Geol Survey

HICKORY GROVE POTENTIAL WETLAND MITIGATION SITE:
FINAL HYDROGEOLOGIC CHARACTERIZATION REPORT

U.S. Route 14, Cary,
McHenry County, Illinois
(Federal Aid Project 305)

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Coastal and Wetlands Geology

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Illinois State Geological Survey
615 East Peabody Drive
Champaign, IL 61820–6964

Submitted Under Contract No. AE89005 to
Illinois Department of Transportation
Bureau of Design and Environment, Wetlands Unit
2300 South Dirksen Parkway
Springfield, IL 62764

August 27, 1996

Illinois State Geological Survey
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EXECUTIVE SUMMARY

The hydrogeology and geochemistry of the Hickory Grove fen in McHenry County, Illinois were characterized between December 1993 and December 1995. Restoration activities at this site are being considered to provide mitigation for wetlands impacted in the reconstruction of Illinois Route 14 through Cary, IL. The fen has been partially drained by two ditches and field tiles. Ground water is discharged from sand and gravel in the uplands south of the fen. Water flows through the fen northeastward on land surface and through sediments that infill the Fox River valley. The east–west ditch causes drawdown of water levels in adjacent areas and intercepts ground-water flow, causing drainage of area 3, a large area north of the ditch. In addition, field tiles were placed in area 2, south of the east–west ditch and east of spring run A, also causing drainage. It is recommended that the field tiles be removed from area 2 to raise water levels and possibly restore wetlands hydrology. However, the east–west ditch also causes drawdown of water levels along the north side of area 2; the effect of the ditch cannot be mitigated in this area, so it is recommended that in this segment the ditch not be manipulated. In area 3, the northward-flowing surface and ground water must be restored to achieve wetland hydrology. Therefore, it is recommended that the east–west ditch be filled west of spring run A, allowing northward flow to occur. To prevent erosion of the fill material, it is recommended that riprap berms be placed across the ditch line at intervals; clay berms should also be emplaced to prevent ground-water flow eastward through the fill down the former ditch line. It is expected that the area of wetland hydrology will be increased by these actions in areas 1 through 3, but fen will only be restored in areas 1 and 2, because area 3 was likely not fen prior to drainage. Geochemical analysis of surface and ground water showed all samples were rich in calcium and magnesium as required by calcareous fen vegetation, but no spatial differences were revealed that would allow delineation of areas affected by drainage or altered flow paths. Continued geochemical sampling will not provide any additional insights and will be discontinued. Post-construction monitoring of ground- and surface-water levels will be performed for a period of 5 years ending in February 2001, or less if required by IDOT. At that time, a Final Monitoring Report will be submitted that evaluates the success of restoration activities and documents any increase in the areal extent of wetland hydrology.

The text and illustrations in this document have received limited scientific and editorial review.

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INTRODUCTION

This report was prepared by the Illinois State Geological Survey (ISGS) to provide the Illinois Department of Transportation (IDOT) with final conclusions regarding the hydrogeologic characterization of a proposed wetland mitigation site described below. The IDOT requested that the ISGS determine the suitability of the study area for wetland mitigation.

Present hydrogeologic conditions and past alterations to site drainage are addressed, with conclusions made regarding the potential of the site for wetland restoration. Data regarding surface- and ground-water levels and geochemistry collected from December 1993 through December 1995 are reported. In February 1996, restoration of wetlands began at the site. Water-level monitoring has continued in order to determine the effects of the restoration activities. A Final Monitoring Report that describes the hydrogeologic conditions after restoration will be submitted at the end of the monitoring period as established by permitting requirements (normally 5 years) or less if required by IDOT.

The Hickory Grove site (fig. 1) is located in McHenry County in the south half of section 5, T43N, R9E, in the southeastern quadrant of the intersection of Hickory Nut Grove Road and South Rawson Bridge Road approximately 3 kilometers (km) (2 miles) (mi) northeast of Cary, Illinois. The site is located mostly within the Fox River valley in the Hickory Grove Conservation Area, and is managed by the McHenry County Conservation District (MCCD).

The study area contains the Hickory Grove fen (Morris et al. 1994) which has been partly drained by ditches and field tiles for past agricultural usage. Fens are peat-forming wetlands supported by alkaline ground-water discharge that causes high-pH soil conditions and creates an environment in which calciphilous plants thrive (Eggers and Reed 1987). The purpose of this report is to identify the hydrogeologic and geochemical conditions present in the fen and surrounding area (fig. 2), to determine the effects of past drainage attempts, and to identify areas in which wetland mitigation and restoration may be possible.

METHODS

The geology of the site was characterized by drilling 23 borings (fig. 3) using various methods as required by site conditions and described as follows. Two borings (1R, 2R) were made in the uplands south of the fen using a Mobile B-30S drilling rig, which collected a continuous, 75-millimeter (mm) (3-inch) (in.) diameter core using a 1.5-meter (m) (5-feet) (ft) split-spoon sampler. A Giddings soil probe was used to obtain a continuous core 75-mm (3-in.) in diameter from a boring (1G) in the Fox River floodplain north of the fen. Within the fen and the floodplain to the north, fourteen borings (1–14) were made using a hand auger 75-mm (3-in.) in diameter. Six additional borings (1S–6S) were made in the fen using a soil probe. Geologic logs for each boring, and cross sections showing each unit of sediments encountered are included in Appendix A. The locations of the boreholes and lines of the cross sections are shown in figure 3.

The hydrology of the site was characterized by measuring ground-water levels monthly in monitoring wells (fig. 3) installed at various depths in selected geologic borings. Monitoring well 2R was installed through the hollow-stem auger of the Mobile B-30S drill rig. Monitoring wells 1G, and 1 through 14 U and/or L (upper and lower screened intervals) were installed in open boreholes made using a hand auger or Giddings rig. Well casing and screen consisted of 2.54-cm (1-in.) diameter PVC pipe. Well screens were between 0.30 and 0.75 m (1.0–2.5 ft) in length, and contained slots 0.25 millimeter (mm) (0.01 in.) wide. Well screens were packed with quartz sand 0.25 to 0.50 mm (0.01–0.20 in.) in diameter. Borings were then backfilled to the surface with bentonite. Well development consisted of pumping

the wells with a peristaltic pump until clear water was obtained. Appendix B lists all well construction measurements. Surface-water levels were measured at three stage gauges (A, B, and C) located within ditches that cross the site. Locations of monitoring wells, stage gauges and the ditches are shown in figure 3. The elevations of stage gauges and wells were determined relative to an arbitrary benchmark by leveling to third-order accuracy using a Sokkia B-1 automatic level and a fiberglass extending rod. In Spring 1996, the arbitrary benchmark was surveyed to a benchmark established by IDOT; all relative elevations shown in this report can be converted to absolute elevations by adding 195.795 m. Relative water-level elevations in wells and on stage gauges, and depths to water in wells referenced to land surface are reported in Appendix C.

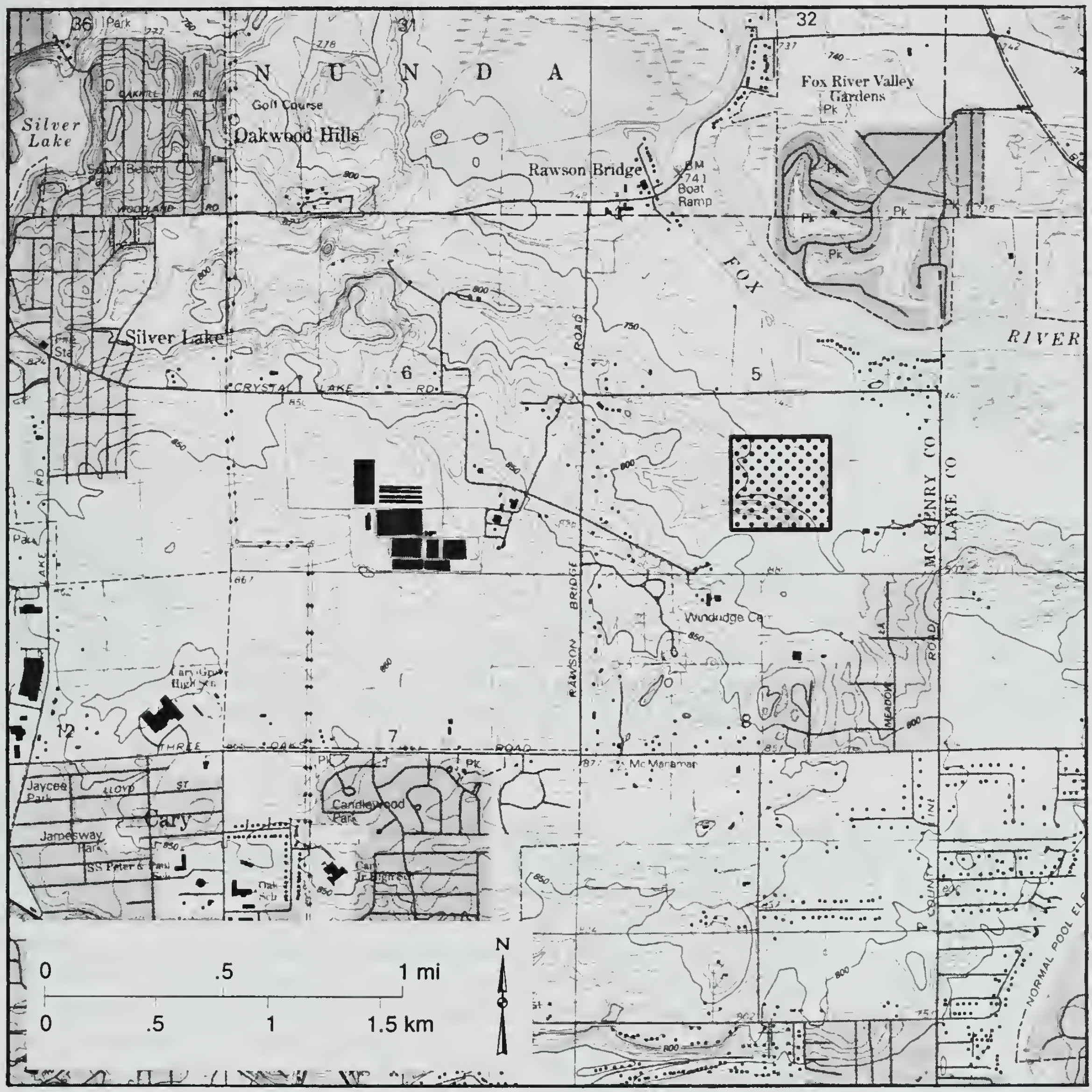


Figure 1 Study area (stippled) and vicinity as shown on the Barrington 7.5-minute topographic map (USGS 1993). Contour interval is 10 ft (3 m).

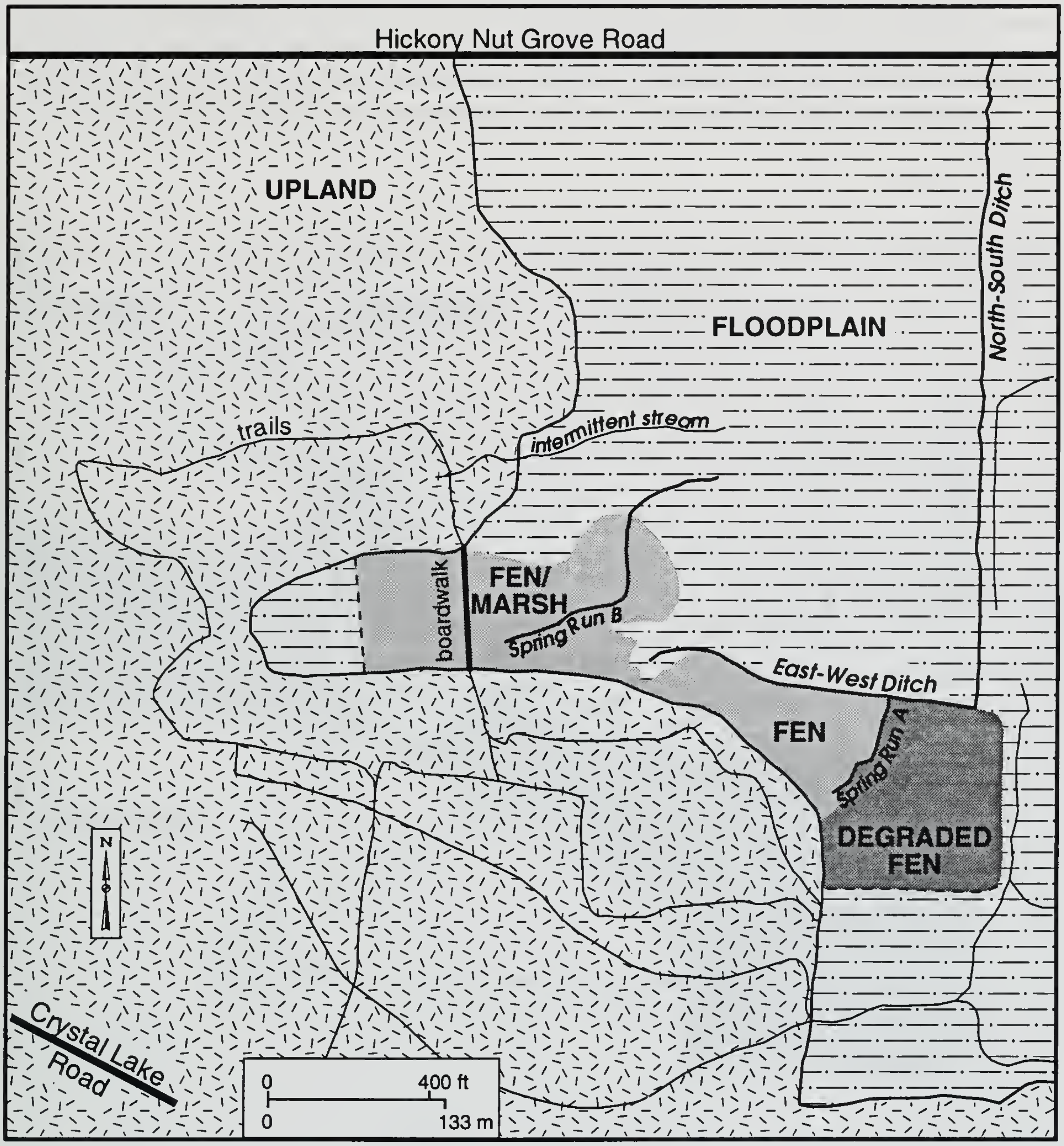
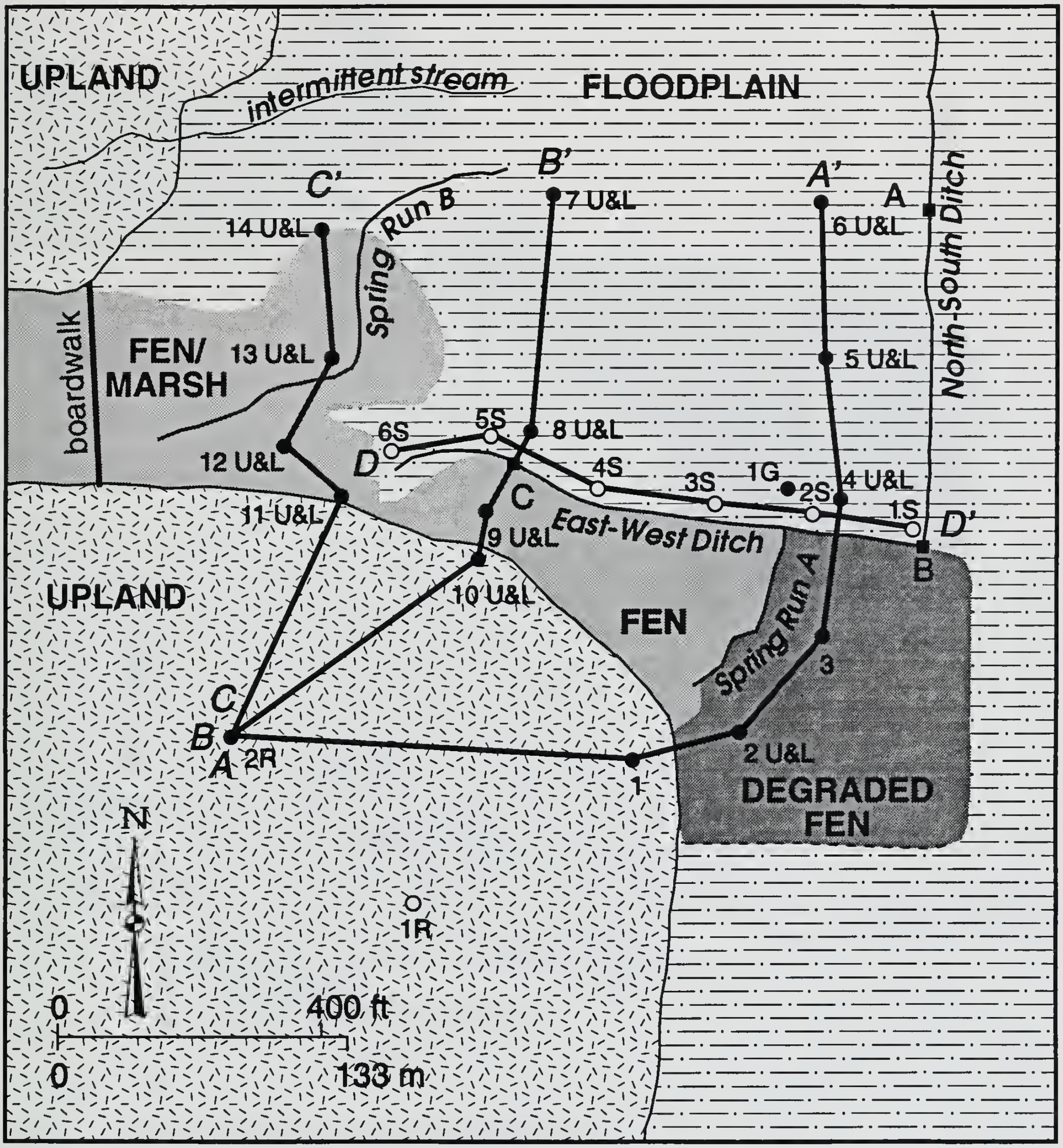


Figure 2 Site map showing the areal extent of upland, floodplain, fen, degraded fen and fen/marsh at the Hickory Grove Conservation Area. [Map based on aerial photography from IDOT (date unknown) and plant community delineations from Morris et al. (1994)].

Geochemistry of the study area was characterized through quarterly sampling of surface water from ditches and springs and ground water from selected monitoring wells (fig. 4). Samples from surface-water stations were collected using a 1-liter (L) (0.26-gallon) (gal) Nalgene dip sampler, placed into labelled 0.125- and 0.250-L (0.033- and 0.065-gal) Nalgene bottles and kept on ice for conventional water quality and inductively coupled plasma spectroscopy (ICP) analysis. The remainder of the sample was used for field measurement of the following parameters: pH, oxidation/reduction potential (redox potential), conductivity, and temperature. The samples for ICP analysis were filtered in the laboratory within 36 hours of collection prior to being acidified. The samples analyzed for conventional water quality were not filtered or acidified. Results of chemical analyses are reported in Appendix D.

Water from sampled monitoring wells was obtained using a Masterflex hand-powered peristaltic pump with silicone tubing. Wells were purged until water temperature and pH stabilized or until the well was pumped dry, then a 1-L (0.26-gal) sample was collected as the well refilled. Samples from wells were handled in the manner described above.



o geologic boring

● geologic boring and monitoring well(s)

■ stage gauge

Figure 3 Locations of borings, wells, stage gauges, and lines of cross section.

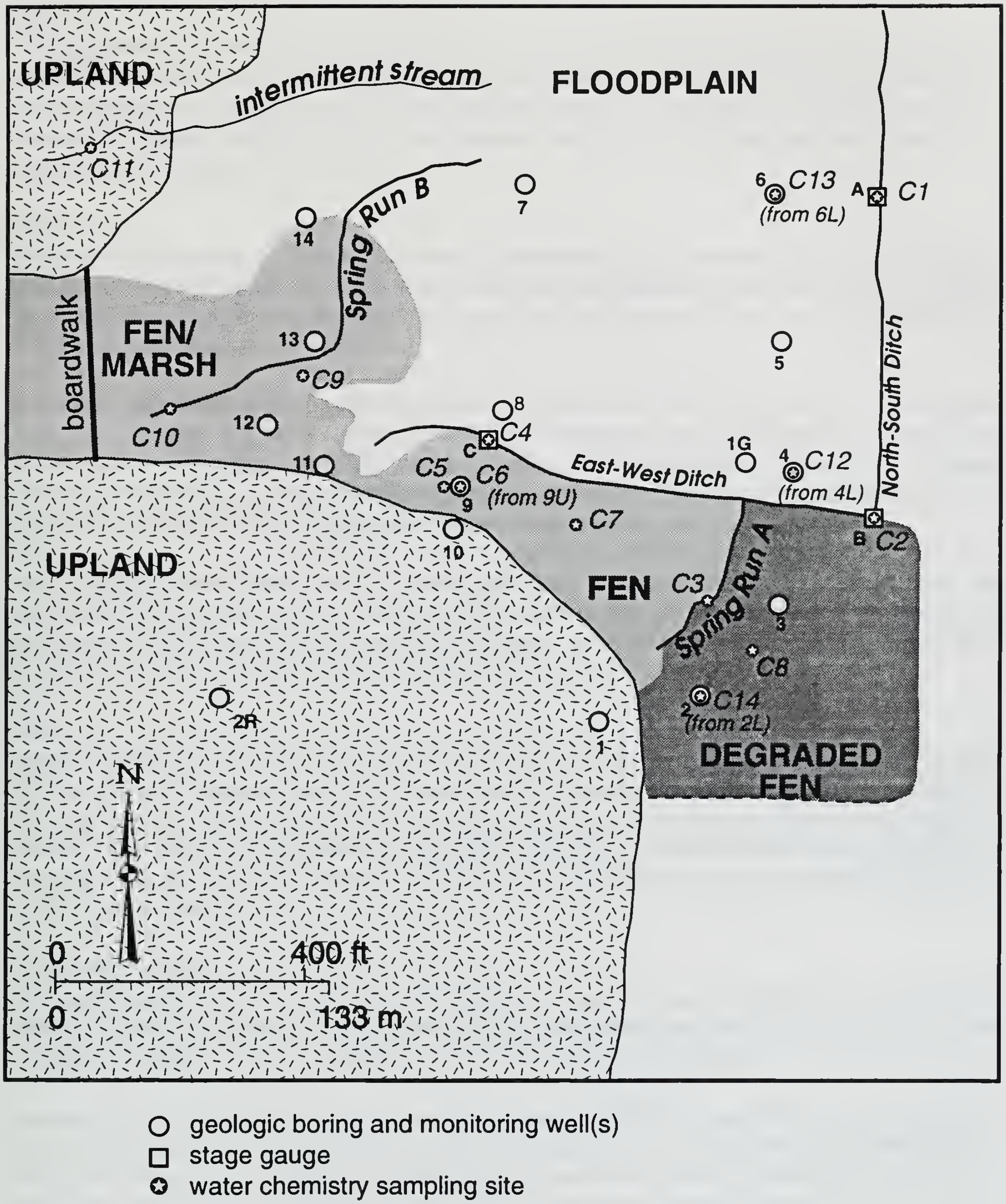


Figure 4 Locations of water-chemistry sampling sites.

GEOLOGY

Regional Setting

Topography

A topographic map of the site (fig. 1) indicates that total relief is approximately 18 to 21 m (60–70 ft) (U.S. Geological Survey 1993). The land surface of the site slopes from the uplands on the south and west toward the Fox River floodplain on the northeast.

Bedrock

The uppermost bedrock unit at the Hickory Grove site consists of silty and shaly dolomites of the Alexandrian Series of the Silurian System (Willman et al. 1967). Bedrock units dip to the northeast approximately 3.3 meters per kilometer (17.7 feet per mile) (Willman 1971). The site is located within a partly-filled bedrock valley which trends east–west across the study area (Herzog et al. 1994).

Sediments

Bedrock is overlain by unlithified Quaternary sediments approximately 60 m (200 ft) thick in the uplands on the south and west sides of the fen and approximately 32 m (105 ft) thick in the Fox River floodplain on the north and east sides of the fen (Piskin and Bergstrom 1975, and ISGS well records on file).

In the Fox River floodplain, sediments consist of less than 6 m (20 ft) of each of the following units in order from the land surface downward: Grayslake Peat, silt and clay of the Carmi Member of the Equality Formation, sand and gravel of the Mackinaw Member of the Henry Formation and sand and gravel of the Haegar Member of the Wedron Formation (Specht and Westerman 1976); other sediments may be present below these units as well.

Beneath the uplands, sediments consist of diamicton interlayered with sand and gravel, and are classified as part of the Wedron Formation of the Wisconsinan Stage (Berg and Kempton 1988). Diamicton is a term used to refer to all very poorly sorted sediments such as glacial till and debris flows, without implying an origin of the deposit.

Soils

Soils in the fen and Fox River floodplain are the following: Harpster silty clay loam, Harpster silt loam, and Houghton peat (U.S. Department of Agriculture 1965). All of these soils are listed by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) as hydric (U.S. Department of Agriculture 1991). Soils located in the uplands south of the fen are the Rodman–Casco complex and Fox silt loam to loam and are not listed as hydric by the NRCS.

Geologic History

The sediments at this site reflect the effects of several late Wisconsinan glaciers that advanced across the site. Each glacier partially eroded the deposits of earlier glaciers and deposited glacial till and outwash on top of the remaining sediment.

Sediments mapped in the vicinity of the site indicate the following late Wisconsinan geologic history. Outwash from late Wisconsinan glaciers eroded and exposed the deposits of earlier glacial advances in and along the valley of the present Fox River (Reinertsen et al. 1993). Sand and gravel outwash deposits of the Haegar Member were exposed in the valley floor. Outwash capped with glacial till of the Haegar Member was exposed in the uplands adjacent to the valley. Later, sand, silt, and clay were deposited in the floodplain by outwash and flooding in the Fox River valley. Lastly, peats were deposited in poorly drained areas of the floodplain and in fens along valley walls.

Site Characterization

As shown in the geologic cross sections (Appendix A), the uppermost unit of sediments at the site is black peat (peat unit A). Peat unit A occurs as the surface deposit throughout the fen and adjacent floodplain area, but has a sharply defined uphill limit along the southern edge of the fen. This uphill limit slopes approximately 5 m (16 ft) from west to east across the study area. Peat as thick as 2.3 m (7.5 ft) occurs in the southwestern portion of the fen,

and thins to approximately 0.15 m (0.5 ft) in the northeastern portion of the fen. The structure and preservation of the peat varies greatly throughout the study area. A downward sequence of fibrous to sapric peat with peaty structure is preserved in the southwestern portion of the fen. However, north of the east–west ditch, little fibrous peat is preserved at the surface. In these areas, unit A is decomposed and appears more clastic, less elastic, and has the characteristics of muck. A layer of brownish-white tufa, approximately 0.1 to 0.3 m (0.3–1.0 ft) thick is present near the base of unit A. This layer is friable, crystalline, fossiliferous, and may be either discrete, nodular or dispersed within peat.

Peaty silt (unit B) is present beneath the fen and floodplain area, and is composed of olive brown to gray clayey silt bedded with very sapric peat. This unit contains abundant wood, root, and shell fragments. This unit is between 0.30 m and 0.75 m (1.0–2.5 ft) thick. This unit has differing character throughout the area depending on the amounts of peat and clayey silt present. Beds are indistinct and vary in thickness. Sand and gravel are present in very small amounts.

Beneath the area covered by peaty silt unit B, sandy silt unit C is present. This unit is very heterogeneous, and contains beds of clayey silt, sand, gravel, and some peaty, organic concentrations. Some beds contain varying amounts of some or all of the above materials. This unit is between 0.75 and 1.60 m (2.5–5.2 ft) in thickness. The sand and gravel content of this unit is higher than that of peaty silt unit B. The southward extent of the unit is difficult to determine, as it may merge with upland sandy units beneath the fen.

Beneath a portion of the area covered by sandy silt unit C, silt unit D is present. This dense, clayey silt unit was penetrated up to 2.14 m (7.02 ft) in borings in the floodplain area. This unit was not encountered beneath most or all of the fen, and may only underlie the floodplain area.

Sediments at land surface south of the fen are diamicton interlayered with sand and gravel of the Haegar Member of the Wedron Formation. These sediments are overlain in the fen and floodplain areas by the sediments described above. Only those units that apply to the discussion in the remainder of the report will be described here, but all sediments are fully described in logs for borings 1R and 2R (Appendix A).

Five units described in boring 2R may have influence on the hydrogeology of the fen: three diamicton units separated by two gravel-containing units. These units are labelled in cross sections shown in Appendix A. Sand and gravel unit J occurs between the relative elevations of 37.0 to 39.5 m, which is approximately the elevation of the upper limit of the southwestern portion of the fen. Sand and gravel unit L occurs at a relative elevation of 31.25 to 34.50 m, which is approximately the upper limit of the southeastern portion of the fen. Diamicton units I, K, and M occur above, between, and below these units, respectively. It was not possible to determine the structural orientation of these units.

The relationship of the east–west ditch (fig. 2) to adjacent sediments was also investigated because the amount of downcutting may affect mitigation options at this site. Borings 1S through 6S were made to determine the geology adjacent to the ditch. Borings were made 5 m (16 ft) north of the ditch. Cross section D–D′ (Appendix A) shows the relationship of geological units and the elevation of the adjacent ditch, and indicates that the greatest amount of downcutting occurs where the adjacent stream bed has eroded downward into peaty silt unit B east of boring 2S.

Conclusions

Sediments of the Haegar Member of the Wedron Formation were deposited in the study area during the Late Wisconsinan Stage. Later erosion formed the Fox River valley and exposed these sediments. These sediments include diamicton units I, K, and M, and sand- and gravel-containing units J and L. These sediments crop out or subcrop in the upland slope adjacent to and beneath the fen as shown in the cross sections in Appendix A.

Later, sediments infilled the Fox River floodplain. It is likely that silt unit D was deposited from a lake or backwater in a short period of time, as no macrophyte fragments or sedimentary structures are present. This unit is also not present at higher elevations in the fen, indicating a flood-type deposit, perhaps meltwaters from a late glacial event.

Afterward, sandy silt unit C was deposited in the floodplain and along the upland slope. This unit is heterogeneous and contains mixed and poorly bedded units of clayey silt, sand, and dolomitic and cherty gravel. Organic matter is present, but rare, indicating that vegetation may have begun to be established at the site during this time period, but was not yet being readily preserved. Sand and gravel from the uplands may have been washed downslope into the floodplain, where sand, silt, and clay may have been accumulating during floods or in isolated backwater environments.

Sandy silt unit C grades upward into peaty silt unit B, indicating a change in depositional environment. Less coarse clastic material was being deposited in the study area; the reduction may have been caused by vegetation establishment on the upland areas or reduced deposition of bed load from floods. Wetland vegetation was established at this time and began to be preserved as peat. Clayey silts are bedded with highly sapric peats, indicating that wetlands alternated with small lakes or backwater areas that may have received some flood sediment. Rare granule and gravel-sized dolomites and cherts are present in this unit, possibly indicating some erosion from the adjacent uplands. Abundant wood fragments and roots are preserved in this unit

Peat unit A is present at land surface within the fen and the floodplain, and indicates a change to the modern depositional environment from peaty silt unit B. This unit is actively being deposited within the fen. At the base of this unit, a layer of tufa or marl is present that may be a postdepositional accumulation precipitated from ground water flowing along the base of peat unit A. Ground water is likely saturated with calcium carbonate, as evidenced by precipitation of tufa occurring at present on debris and gravel in the springs of the fen. In the study area north of the east–west ditch, the peat is oxidized and compacted to an extent that little fibrous peat is left at the surface; the higher mineral-matter content and lack of a peaty structure indicate that in this area the unit is muck.

HYDROLOGY

Regional Setting

Water-well records for this area indicate that water for some private homes is withdrawn from various sand and gravel aquifers in the Haegar Formation sediments. Well records indicate that wells may be 15 to 60 m (50–200 ft) deep. Larger residential, industrial and municipal wells are screened in both shallow and deep bedrock aquifers (Reinertsen et al. 1993).

Local slope and surface-water flow is from the uplands south and west of the site toward the Fox River on the northeast. Surface flow is low in this area, as the sand and gravel in the uplands is conducive to infiltration. Regional ground-water flow is presumed to have a similar

directional pattern, as the source of recharge in this area is likely to be the large upland area to the south and west of the site.

Annual rainfall in the region is approximately 86 cm (34 in.), and is highest in the spring and summer months (Bowman and Collins 1987). Most recharge is estimated to occur during spring, fall and winter when precipitation is moderate or high and when evapotranspiration is low (Hensel 1992). Annual precipitation at O'Hare Airport in Chicago, located approximately 30 km (20 mi) southeast of the site, was 83% and 92% of normal in 1994 and 1995 respectively. In 1994, precipitation was below normal except during the months of February, June, October, and November (National Oceanic and Atmospheric Administration 1995). In 1995, rainfall was below normal except in January, April, May, October, and November. In regard to determining wetland hydrology in Illinois, April and May are the critical months; beginning in May, evapotranspiration rates increase greatly (Bowman and Collins 1987) and dry up many wetlands until fall. Therefore, 1994 can be considered normal to dry, and 1995 can be considered normal to wet. This suggests that the monitoring period may give a good indication of how the site will react in a wide range of weather conditions.

Site Characterization

Ground Water

The purpose of the hydrogeologic investigation was to identify aquifers, aquitards, and ground-water flow paths in the fen and adjacent areas in order to estimate the effects of alterations to the site. Past alterations include the ditching of the site through points A, B, and C (fig. 3), and the installation of field tiles in various portions of the site adjacent to the ditches. Drainage tiles and outlets have been observed in the area near wells 2 and 3. Twenty-eight monitoring wells were installed at various depths in several geologic units throughout the study site. Well locations are shown in figure 3. Geologic cross-sections with well diagrams are shown in Appendix A. Relative water-level elevations and depths to water referenced to land surface in shallow (upper) monitoring wells are shown in figures 5 and 6 respectively. Figures 7 and 8 show relative water-level elevations and depths to water in deep (lower) monitoring wells, respectively. Data reported were collected between December 1993 and December 1995.

Units A, C, J, and L are the primary aquifers or units of importance to this study. Peat unit A is important in that it is at land surface in the fen and floodplain areas, and ground-water conditions therein will determine if an area has wetlands hydrology, meaning that it qualifies as a wetland according to U.S. Army Corps of Engineers (1987) guidelines. Sandy silt unit C was observed as saturated and was capable of providing ground water sufficient to fill the annulus during drilling. Sandy gravel units J and L occur in the upland adjacent to and beneath the fen, and may act as source beds for the ground water that is discharging in the fen; these units occur between beds of silty clay diamicton (units I, K, and M) that likely serve as aquitards. Silty units B and D in the floodplain area normally did not provide adequate water to fill the annulus during drilling and were generally described as unsaturated; these units may be acting as aquitards.

While drilling borings 1R and 2R, units E through K were described as unsaturated. Water levels (fig. 7) measured in sandy gravel unit L during the study period were between 5 and 8 m above the upper surface of the bed, and were higher in elevation than the highest portion of the fen as marked by the southern limit of peat unit A. Therefore, unit L is the only identified source of ground water under hydrostatic pressure sufficient to discharge throughout the fen.

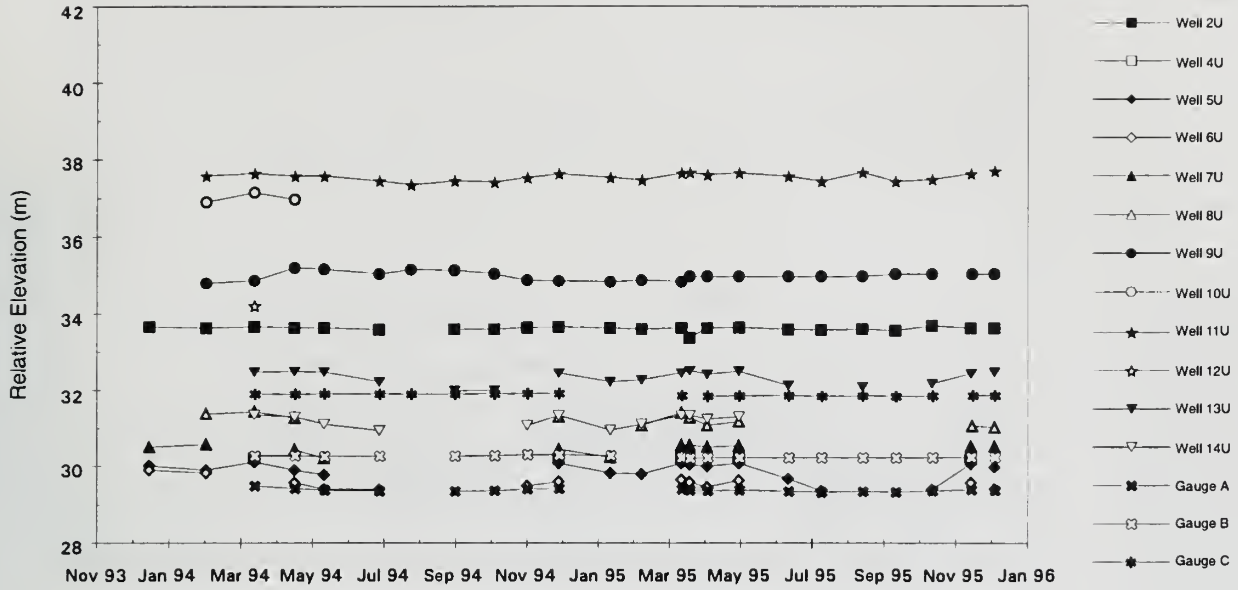


Figure 5 Hydrograph showing relative water-level elevations in upper monitoring wells and on stage gauges in the study area between December 1993 and December 1995.

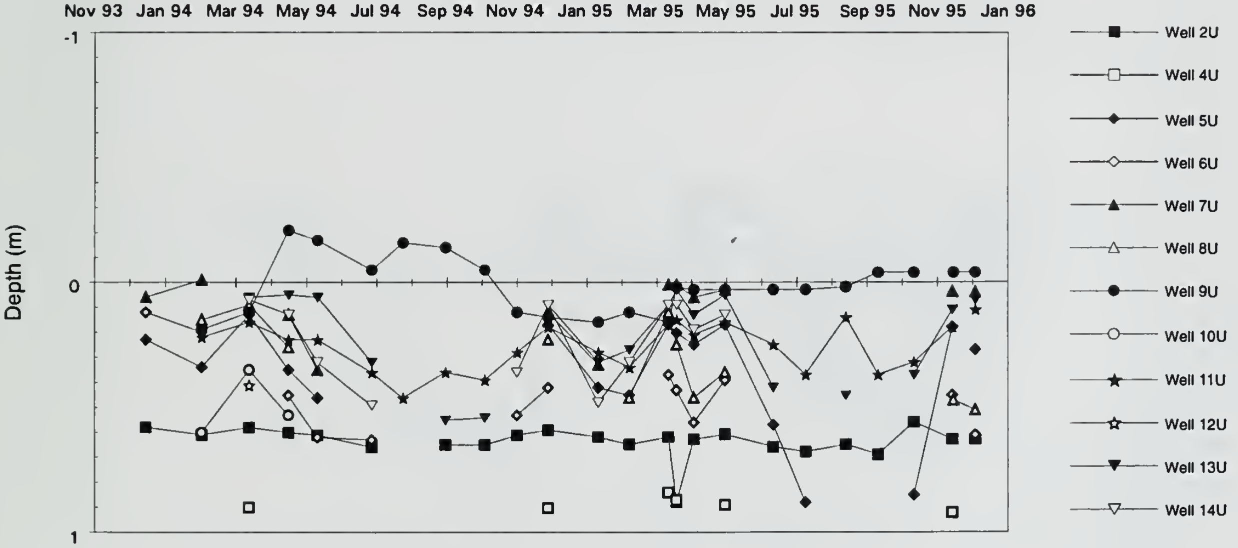


Figure 6 Chart showing depth to water, referenced to land surface, in upper monitoring wells in the study area between December 1993 and December 1995. Minus sign indicates water above land surface.

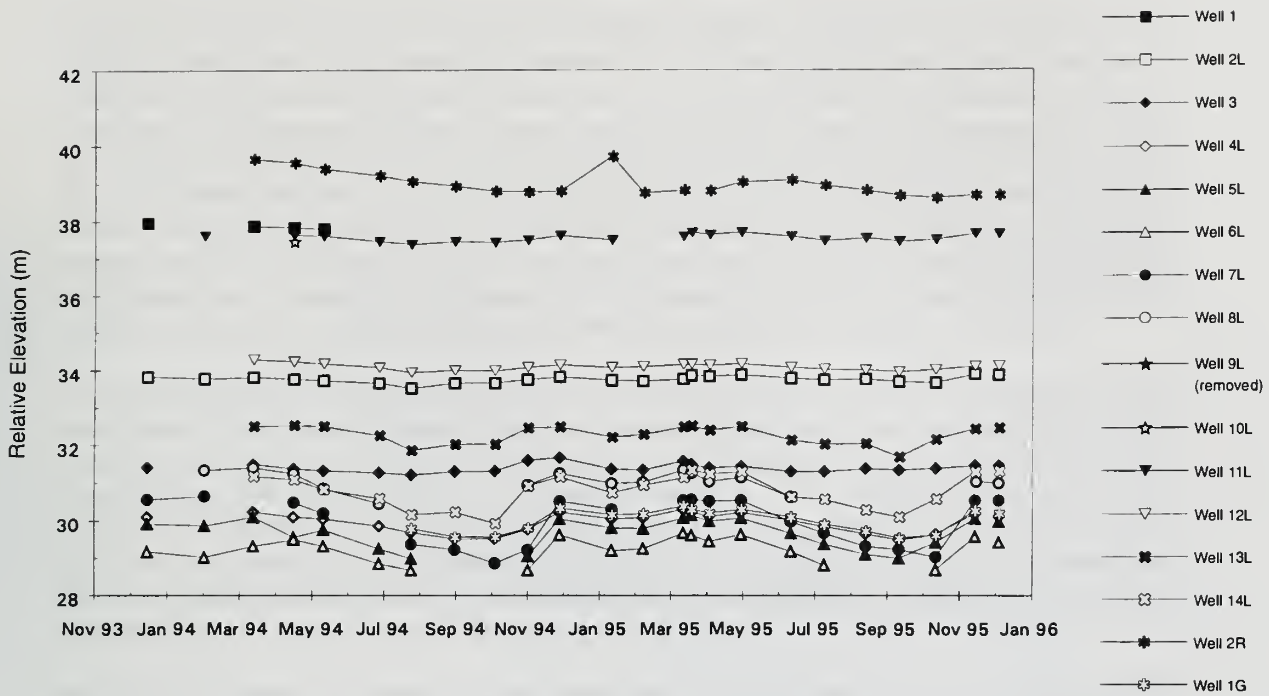


Figure 7 Hydrograph showing relative water-level elevations in lower monitoring wells in the study area between December 1993 and December 1995.

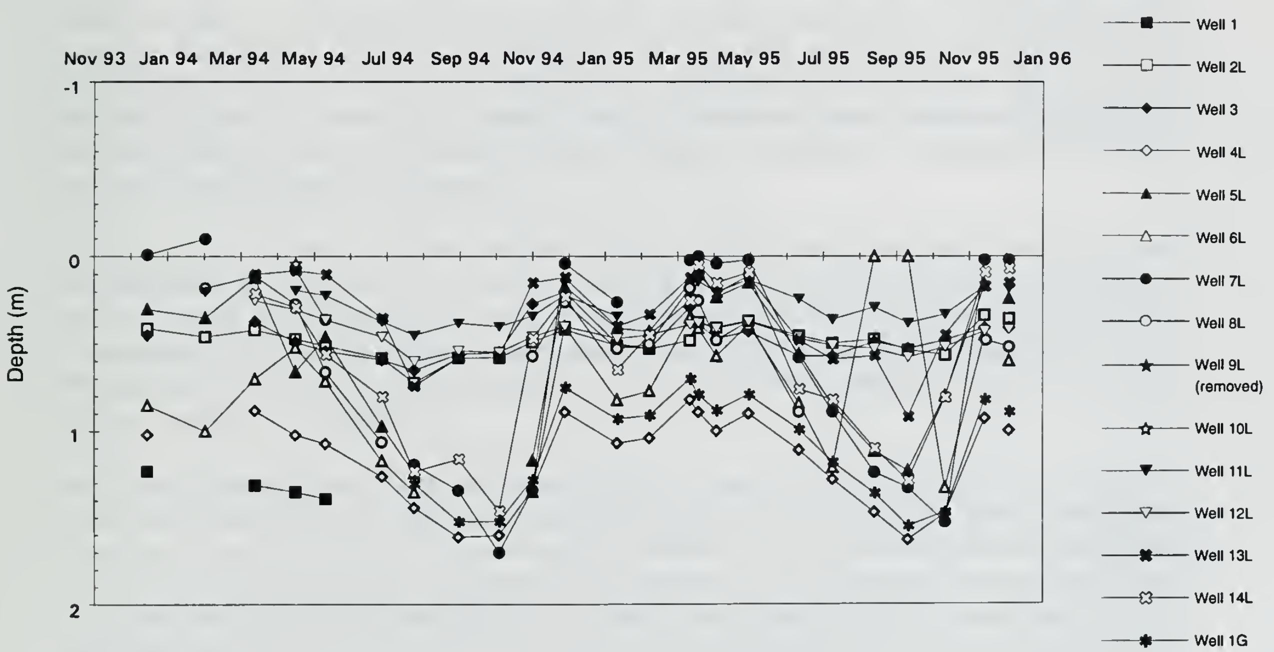


Figure 8 Chart showing depth to water, referenced to land surface, in lower monitoring wells in the study area between December 1993 and December 1995. Minus sign indicates water above land surface.

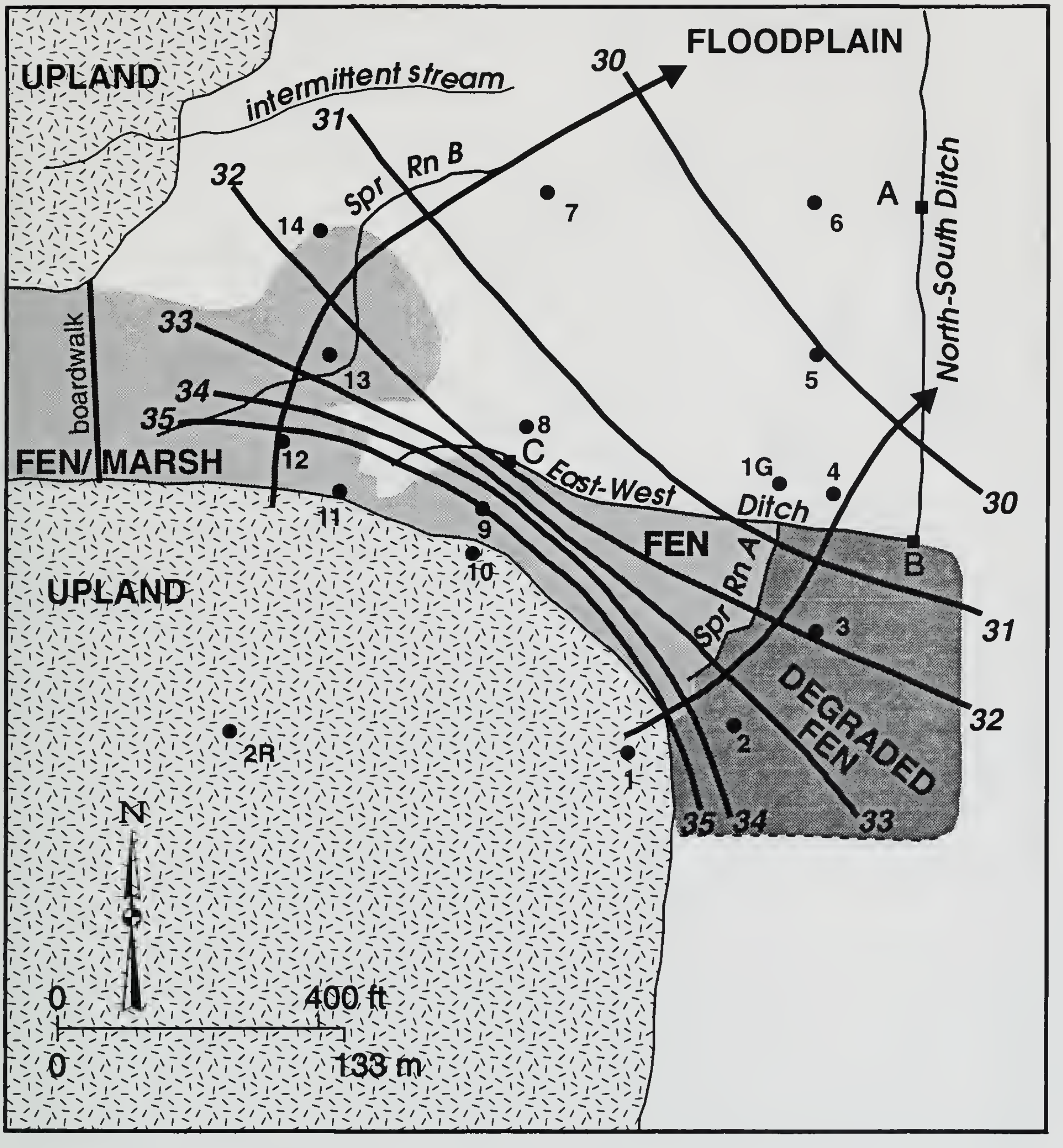
Because units A and C provided ground water sufficient to rapidly fill the annulus during augering, wells were also installed in these units. Wells in peat unit A were installed to determine ground-water levels in the soil zone, and may show areas of drainage or wetlands hydrology. Comparison of ground-water levels in units A and C will determine vertical hydraulic gradients and may show the areal extent of ground-water discharge. Shallow wells (2U–14U) were screened at approximately 0.45 to 0.75 m (1.5–2.5 ft) in depth and were primarily installed in peat unit A but extended into peaty silt unit B where unit A is thin. Deeper wells (1L–14L) were screened primarily in sandy silt unit C. Contour maps showing the potentiometric surface and estimated ground-water flow paths in peat unit A (fig. 9) and sandy silt unit C (fig. 10) were prepared from data collected on March 21, 1995.

Water levels measured in shallow wells (2U–14U) are shown in figure 5. Generally, water levels show a rise in spring when recharge is normally high, and a decline beginning in early summer when evapotranspiration is normally highest. The depth to water below land surface in wells screened in peat unit A is shown in figure 6. For wetlands hydrology to be demonstrated, the water table must be within 30 cm (1 ft) of the land surface for greater than 12.5% of the growing season; durations of 5 to 12.5% of the growing season indicate that wetlands hydrology may be present, and less than 5% indicates that wetlands hydrology is not present (U.S. Army Corps of Engineers 1987).

The growing season is defined as the period that soil temperatures are at or above 5°C (41°F) at a depth of 0.50 m (1.67 ft) (U.S. Army Corps of Engineers 1987). Because soil-temperature data were not collected onsite and are not readily available for McHenry County, this period must be estimated based on regional data. On average, the growing season in Du Page County begins around March 24 according to soil-temperature data collected at the Morton Arboretum (P. Kelsey, pers. comm.), which is located approximately 50 km (30 mi.) to the south. In McHenry County, the growing season will likely begin a few days later due to its more northern location. Therefore, the growing season for this site is estimated to begin on April 1. This date coincides with the observed emergence of sedge and other plants at the Hickory Grove site. The end of the growing season is estimated to be on average November 1. Therefore, water levels in peat unit A must be within 30 cm (1 ft) of the land surface at this site for at least 27 days to positively show wetlands hydrology, for at least 11 days to possibly show wetlands hydrology, and less than 11 days to indicate that wetlands hydrology was not present.

Based on the growing season defined above, during 1994, wetlands hydrology was demonstrated in wells 5U, 7U, 9U, 11U, 13U, and 14U (fig. 6), and may be present in well 8U. Wells 2U, 4U, 6U, 10U, and 12U did not show wetlands hydrology. Water levels in the spring of 1995 show similar results, except well 8U does not show wetlands hydrology. Water levels show some seasonal variation (fig. 6), although the magnitude of the response between wells varies greatly.

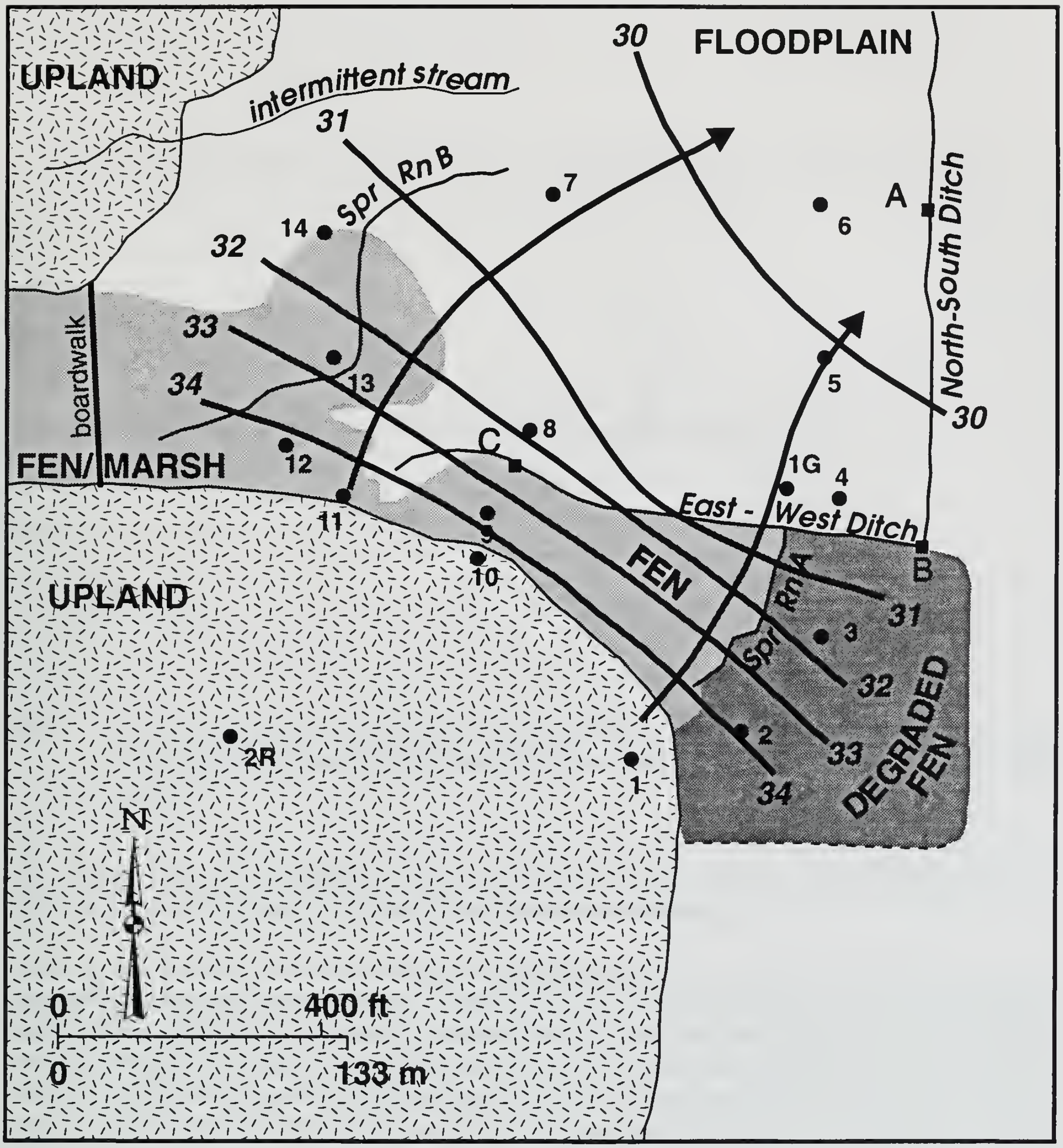
Estimated ground-water flow paths in peat unit A on March 21, 1995 are shown in figure 9. Water-level readings from wells screened in this unit indicate that water levels are highest within the fen and decrease to the northeast. However, any ground-water flow through peat unit A would be intercepted by the east–west ditch because the base of the ditch is located at or near the approximate elevation of the base of unit A, as shown on cross section D–D′ (Appendix A). Some discharge from the ditch northward into unit A is expected and will be controlled by the level of water in the ditch. West of boring 6S the ditch ends and effects on ground-water levels lessen; in this area, ground water and springs flow northeastward from the undisturbed portion of the fen and supply water to peat unit A in that area. Wetlands hydrology extends farther north in this area, as shown by the fen and marsh area in figure 3.



- ● geologic boring and monitoring well(s)
- ■ stage gauge

Figure 9 Site map showing well locations and contours of the potentiometric surface within peat unit A. Water levels were measured on March 21, 1995. Contour interval is 1 m. Arrows show estimated ground-water flow directions.

Figure 8 shows the depth to water from the land surface at each well screened in sandy silt unit C. Water levels in this unit are important because the unit is an aquifer that appears to merge with other aquifers (units L and J) within the fen, and may act as a conduit for conveying ground water from the fen into the floodplain area. Water levels measured in wells installed in the fen and degraded fen areas (2–3L, 11L–13L) indicate that unit C was under artesian conditions throughout the monitoring period. Wells installed in the floodplain (4L–8L, 14L) showed artesian conditions in unit C during winter and spring before water



● geologic boring and monitoring well(s)
■ stage gauge

Figure 10 Site map showing well locations and contours of the potentiometric surface within sandy silt unit C. Water levels were measured on March 21, 1995. Contour interval is 1 m. Arrows show estimated ground-water flow directions.

levels dropped below the top of unit C in the summer; this pattern occurred in both 1994 and 1995. The difference in behavior suggests that there may be differences in the relative importance of water sources supplying each area. Relatively constant levels in wells may indicate areas with significant ground-water inflow, while fluctuating levels may indicate a greater influence of sources that have seasonal variation, such as precipitation or runoff. Seasonal water demands such as evapotranspiration may not greatly affect water levels in

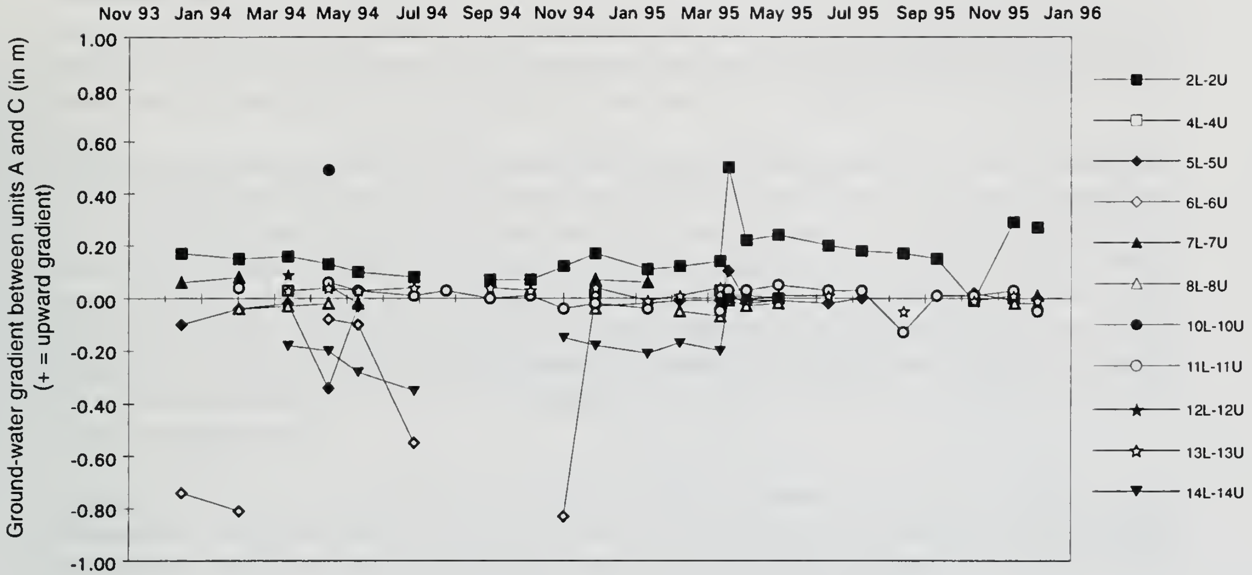


Figure 11 Chart showing ground-water gradient between peat unit A and sandy silt unit C in the study area between December 1993 and December 1995. Positive values indicate an upward gradient.

those areas that receive significant amounts of ground water inflow, while areas that receive less ground-water inflow may have larger seasonal variations.

Water levels fluctuate the most north of a line between wells 3 and 13. Figure 11 shows a comparison of water levels in units A and C; in the aforementioned area, an upward ground-water gradient is regularly present only at well site 7. This indicates that ground-water upflow does not uniformly occur north of the ditch. This may suggest the northward extent of the influence of ground-water discharge, and may act as the northern boundary for the fen. North of this boundary, seasonal changes in the water budget have a greater effect on water levels, possibly allowing nonfen or less hydrophytic vegetation to colonize the area. Alternatively, the fluctuating water levels may have an undetermined cause such as a varying cross-sectional area or insufficient flow to stabilize water levels.

Estimated ground-water flow paths in silty sand unit C on March 21, 1995 are shown in figure 10. Estimates indicate that flow occurs from the southwest to the northeast across the site, from the fen into the floodplain. This pattern has been relatively constant during the monitoring period, although minor seasonal deviations occur.

Surface Water

Surface waters in the study area include ditches, spring runs A and B, and an intermittent stream from uplands to the west. Stage gauges were installed in the ditches at points A, B, and C (fig. 3) so that water levels could be measured. No stage gauges were installed in spring run A due to its short length and discharge into the east–west ditch. No gauges were installed in the intermittent stream or springs on the west side of the site because they lack a distinct channel.

Figure 5 shows water levels in the ditches from March 1994 through December 1995. Water levels are relatively stable and do not freeze in many places, indicating that the source of water in the ditch is likely ground-water discharge.

Conclusions

Sand and gravel unit L supplies ground water that discharges from the fen. Water flows from the uplands on the south and west into sediments that partly fill the Fox River valley. Ground water flows to the north and east through these sediments toward the Fox River.

Water flowing through peat unit A is completely or partially intercepted by the east–west ditch and is carried from the study area. Water levels in peat unit A north of the east–west ditch are controlled in part by the base of the ditch and water levels in the ditch. Water levels in the ditch are stable throughout the year, indicating a significant ground-water input. Water levels in unit C are stable in the fen, but fluctuate in the floodplain area, possibly assisting in the delineation of the extent of ground-water discharge from the fen. The cause of this fluctuation is not known, but may be related to seasonal water demands in the floodplain area. Water levels in unit C are not uniformly high enough to discharge upward into unit A in the floodplain area.

Wetlands hydrology is not present in portions of unit A adjacent to the ditch because of the interception of ground-water flow and drawdown caused by discharge into the ditch. Additionally, field tiles that drain into the ditch likely decrease residence time and help to lower water levels in known tiled areas (e.g. adjacent to wells 2 and 3).

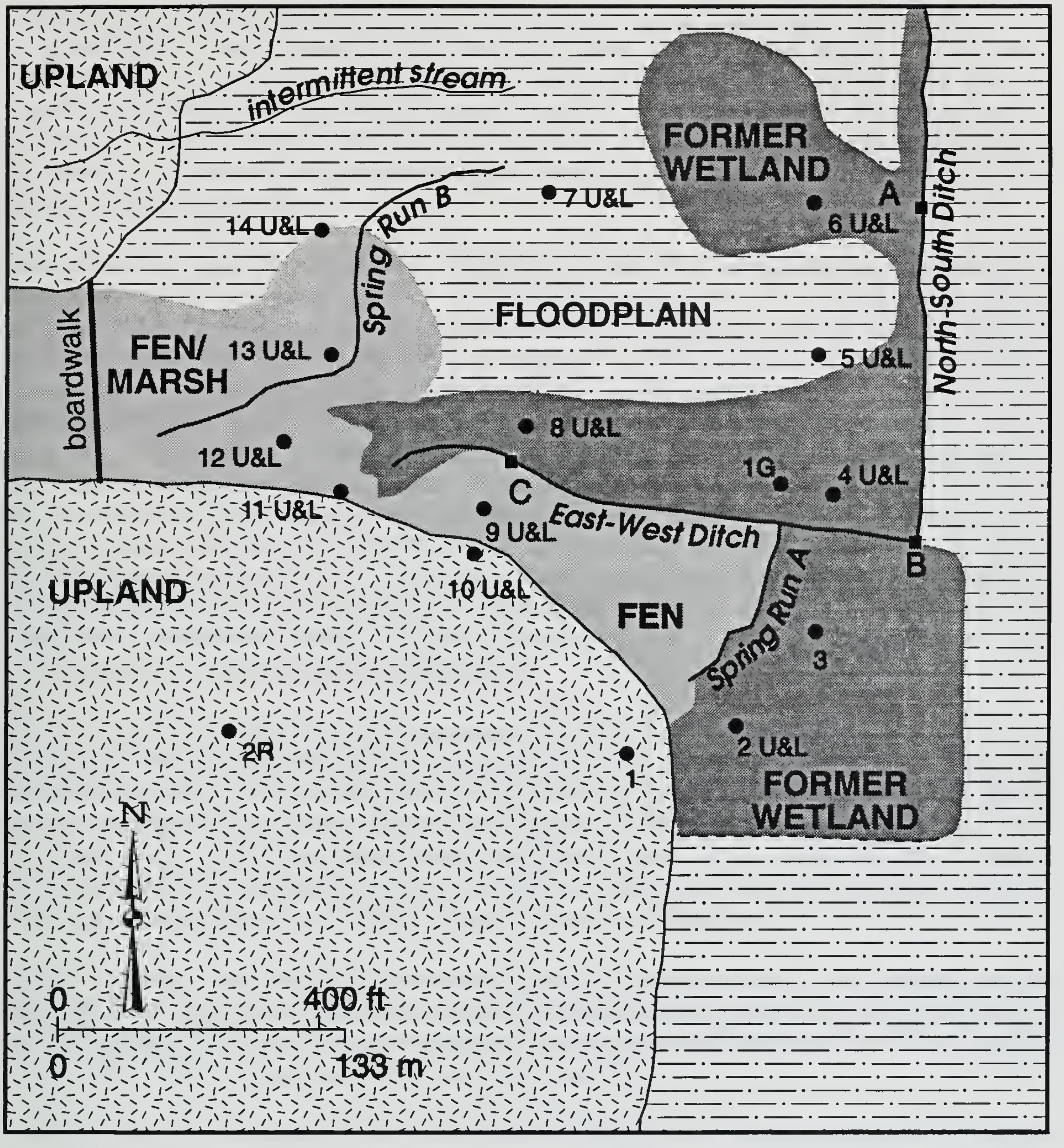
Mitigation Potential of the Study Area

Wetlands hydrology no longer exists in the area shown in figure 12 labelled former wetland. This area was wetland at one time prior to drainage because the soils in the outlined area are classified as hydric (U.S. Department of Agriculture 1991). This area corresponds to the area that encompasses drainage alterations such as ditching and known field tiling.

For the purposes of this analysis, it is assumed that wetlands existed immediately prior to site alteration and drainage; this is assumed because wetlands hydrology exists west of the end of the east–west ditch in areas that are not affected by the drainage and have similar geomorphology. It is also assumed that the source of water that supported these wetlands has not been altered, as evidenced by the continued ground-water discharge in springs and seeps throughout the fen.

Ditches and field tiles help drain peat unit A. Filling the ditch would increase saturation levels in unit A and increase flow northward across the former ditch line. The elimination of field tiles would increase residence time of ground water in unit A and thereby increase water levels. These two factors would likely cause the rehydration of some or all of drained portion of peat unit A, possibly to an extent that would cause wetlands hydrology and to restore jurisdictional wetlands.

To determine if fen wetland would be restored in some or all of the rehydrated area, it is necessary to examine the characteristics of fens in general. At present, there is little information available regarding the hydrogeologic conditions of a fen, so the factors that control the growth or maintenance of a fen are not known. However, it is commonly stated that fens are peat-forming, alkaline environments that are supported by ground-water discharge that is high in calcium and magnesium, allowing calciphilous plants to thrive (Eggers and Reed 1987). It is also assumed that saturation of the land surface throughout much of the year is necessary to prevent the oxidation and decay of the peats within the fen



● geologic boring and monitoring well(s)

■ stage gauge

Figure 12 Site map showing former wetland areas which have been drained.

(Boelter and Verry 1977, Winston 1994). Additionally, the constant influx of alkaline ground water within the soil zone may be required to offset the pH-lowering effects of nonalkaline water sources such as precipitation and runoff.

To test these assumptions, the hydrogeologic conditions within the Hickory Grove fen were examined to determine if the above factors exist. Figure 6 shows the water levels in peat unit A; wells 9U and 11U are within the central portion of the fen where undisturbed peat occurs. Water levels in these wells are within 30 cm (1.0 ft) of the land surface for approximately 90% of the monitoring period and never fall below 50 cm (1.6 ft) in depth,

keeping the peat saturated and anoxic; this is similar to water levels seen in other fen studies (Ingram 1982). Calcium carbonate is being precipitated on rocks and debris in spring run A, indicating that high dissolved levels of these constituents are present. Additionally, figure 11 shows that there is an upward hydraulic gradient in the fen and in the degraded fen (wells 2, 11, 12), indicating that ground-water upflow and occasional ground-water discharge is occurring. Therefore, the commonly-held assumptions regarding fens listed above occur in the Hickory Grove fen.

One additional factor that may help determine if a fen environment will be restored is the magnitude of ground-water upflow. If it is necessary to keep soil conditions constantly alkaline, then it may be necessary for ground water to discharge upward into the root zone for much of the year to offset the effects of nonalkaline water sources such as precipitation. Figure 8 shows that water levels in sandy silt unit C are capable of upflow to within 0.75 m (2.5 ft) of the land surface throughout the monitoring period as measured in wells (11L, 12L) that are located in the undisturbed portion of the fen. Similar hydrology is indicated by springs in the vicinity of well 9L, which was removed not long after installation due to erosion of the annular seal caused by upwelling ground water. In the floodplain area (wells 4L–8L, 13L–14L), the potentiometric surface drops to greater than 0.75 m (2.5 ft) below the land surface during the summer months, indicating that there is no potential for ground-water discharge into the major portion of the root zone during that time period. This may allow nonalkaline water sources to lower soil pH in nonfen locations and allow colonization by noncalciphilous plant species.

Therefore, it is hypothesized that a necessary condition for fen growth or maintenance at this site is that the potentiometric surface in unit C must be within 0.75 m (2.5 ft) of the land surface throughout the year with an upward gradient sufficient to provide a volume of ground water necessary to perpetuate alkaline soil conditions. This condition will be hereafter called fen hydrology. If this condition exists within the area that no longer shows wetlands hydrology, then it is estimated that there is the potential to restore fen wetlands at the study site. If not, then it may be possible to restore wetland but not fen.

Figure 13 shows the area where wetlands hydrology was removed by the drainage of the site. Wells showing fen hydrology are also shown on the map. Based on their hydrogeologic characteristics, areas are also delineated that estimate the mitigation potential of each portion of the study area. These areas are described below.

Area 1, south of the east–west ditch and west of spring run A, is least disturbed. This area also includes the area west of the end of the east–west ditch. Fen vegetation and springs occur. Wetlands hydrology and fen hydrology are present in this area. Some invasion of woody species occurs adjacent to the east–west ditch, where drawdown from ground-water discharge into the ditch has lowered water levels. This area may be affected favorably if the trees are removed and if drawdown is reduced.

Area 2, east of spring run A and south of the east–west ditch, is a degraded fen that has been affected by field tiling and the excavation of the spring run and ditch. Some seepage and degraded fen vegetation occur in areas where field tiles have been eroded through. Wells installed in this area show that wetlands hydrology no longer occurs over the bulk of the site. If wetlands hydrology is restored, it is possible that fen wetland may be reestablished as fen hydrology is present in this area. It may be possible to raise water levels by breaking drainage tiles, but this should not be considered a guaranteed method. The drainage caused by the ditch drawdown has not been evaluated quantitatively so that an estimate of water-level increase is not possible.

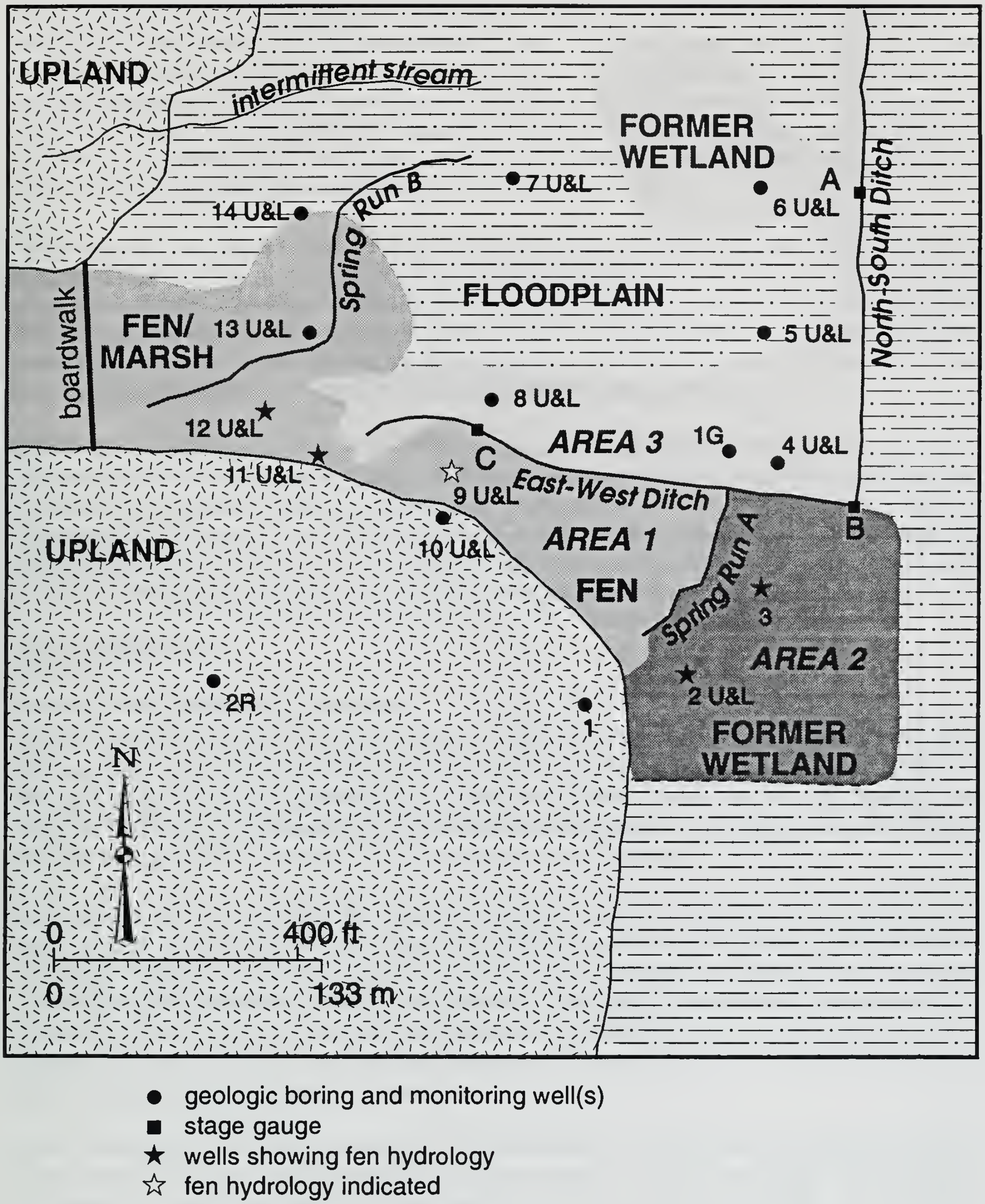


Figure 13 Site map showing potential wetland mitigation areas, and wells exhibiting fen hydrology. Fen restoration may be possible in Area 2, and nonfen wetland restoration may be possible in Area 3. See text for details.

It is recommended that spring run A and the portion of the east–west ditch adjacent to area 2 not be manipulated, as the spring run has likely established an equilibrium that may be unpredictably altered. It also would be problematic to raise water levels in the spring run without significant construction activity, which may adversely affect the adjacent undisturbed areas. Any fill placed into the ditch in this area would likely be rapidly eroded.

Area 3, north of the east–west ditch, has been disturbed from its presumed presettlement condition. In this area, drainage caused by the east–west ditch and possible field tiling has removed wetlands hydrology. If the east–west ditch were filled west of spring run A, then it may be possible to raise ground-water levels in the areas adjacent to the ditch that are now drained. If wetlands hydrology is restored to this area, wetlands restoration can occur. However, fen wetland likely will not be established in this area because fen hydrology is not present, indicating that this area was not fen prior to drainage.

Filling the ditch will require that material with hydraulic conductivity similar to peat unit A be used, and that barriers of low hydraulic conductivity material (i.e. clay) be placed in the ditch at regular intervals (possibly 30- to 50-m spacing) to prevent ground-water flow through the fill down the former ditch line. These barriers should be slightly higher than the surrounding landscape and extend into undisturbed materials on both banks and in the bottom of the ditch. Any construction activity should be performed in dry conditions.

The portion of area 3 east of spring run A will be less affected by this mitigation because the east–west ditch will still interrupt flow in this area. However, some water-level increase can be expected as water levels in the adjacent portions to the west will be raised, causing increased ground-water flow into this portion. It is unclear how far north and east this mitigation will be effective. Post-construction monitoring of the extent of wetland hydrology should be performed to determine the limit of the effects of the mitigation activity.

GEOCHEMISTRY

Purpose and Collection Procedures

Fens are characterized by plants adapted to alkaline conditions and waters rich in calcium and magnesium, normally supplied by ground-water discharge (Eggers and Reed 1987). The Hickory Grove site has experienced an alteration of flow paths caused by ditching and drainage that may have resulted in a change in water source or residence time of waters, possibly altering the sediment and water chemistry of the site.

The purpose of the geochemical sampling program was to characterize the chemistry of water in each portion of the study area. This information will be used to determine the variability of water chemistry in the study area, and to establish a baseline for comparison of conditions to those after potential restoration of the site. Other uses of these data may include the description of natural and degraded fen conditions and their relationship to plant communities, and potential delineation of portions of the study area that receive waters of different source and chemistry, if possible.

Water samples for chemistry screening were collected up to six times at sites numbered C1 through C11 (fig. 4) in May 1994 and October 1995. In February 1995, sites C12 and C13 (wells 4L and 6L, respectively) were added; in April 1995, C14 (well 2L). A description of each of the sites appears in Table 1. The water source of each sampling site is also shown in Table 1. Samples from streams and ditches are classified as surface water, and samples from wells and from the land surface within 2 m (6.6 ft) of a seep are classified ground water.

Samples were not collected if the sampling sites or wells were dry or frozen. Certain sampling sites were discontinued during the monitoring period, including C6 due to erosion around the well casing, C9 because the site was normally dry and because there was duplication with C10, and C11 because the stream does not discharge into the main portion

Table 1 Summary of water-chemistry sampling sites and number of samples collected at each site between May 13, 1994 and October 5, 1995. Sampling sites are shown on figure 4. Results of water-chemistry analyses are located in Appendix D.

Map I.D.	General Location Description	Number of Samples
C1	surface water from north–south ditch at gauge A	5
C2	surface water from east–west ditch at gauge B	6
C3	surface water from spring run A at rock	6
C4	surface water from east–west ditch at gauge C	5
C5	ground water from the seep near well 9	6
C6	ground water from well 9U	2
C7	ground water from the red seep	6
C8	ground water from the seep near well 3 in the degraded fen	5
C9	surface water from the marshy area near well 13	2
C10	ground water from spring run B near well 12	6
C11	surface water from the bridge over the intermittent stream	4
C12	ground water from well 4L	3
C13	ground water from well 6L	1
C14	ground water from well 2L	2
	Total	59

of the study area. Results of chemical analyses are reported in Appendix D, including mean, median, minimum, and maximum values for each sampling point. General use water-quality standards (Illinois Environmental Protection Agency 1994) are also reported in Appendix D for comparison.

Laboratory Procedures and Data

The water quality parameters measured are listed in Appendix D. Details of the analytical procedures are found in Cahill (1985).

Quality Control/Quality Assurance

Standard ISGS quality control/quality assurance (QA/QC) samples were included with samples submitted for analysis. The results were judged acceptable by ISGS QA/QC procedures.

Conclusions

The water samples have a mean value of 95 mg/L of calcium (70–141 mg/L range) and a mean value of 50 mg/L magnesium (31–62 mg/L range). Only one sample exceeded the general use water quality standards during the monitoring period; sample C7 in April 1995 showed iron levels of 1.66 mg/L, exceeding the standard of 1.00 mg/L. Water samples

collected throughout the site are relatively homogeneous, and do not show strong spatial or temporal changes, except as noted below. The data do not support the hypothesis that drainage has altered the geochemistry of the water found in each site sampled. Therefore it is not possible to delineate drained areas based on chemical composition of surface or ground water using this data set.

Water collected from site C7, a seep that has red staining on the vegetation and soils, shows a mean iron value of 0.73 mg/L and range of 0.19 to 1.66 mg/L, much higher than any other sampling site. Oxidation/reduction potentials measured at site C7 show that conditions are often more reducing than any other site. The red staining in this seep is from iron precipitation, possibly enhanced by biological activity. The source of the increased iron in the seep is not known at this time.

Seasonal variation is not readily apparent, with the exception of greatly increased levels of total dissolved carbon (TDC) and dissolved organic carbon (DOC) noted in samples collected in May 1994. The cause of these increased levels is not known, although this sampling date was during a period of low precipitation.

If the samples are grouped according to type of water source (e.g. well, seep, or surface water), other trends can be seen. In samples collected from wells, water samples are generally low in TDC and DOC, and high in total phosphorus in comparison to other groups. It is likely that because the samples have not interacted with peat unit A, TDC and DOC have not been incorporated and phosphorus has not been removed by biota.

Monitoring

Because no strong trends were noted in the characterization, it is not likely that continued monitoring will help identify if restoration activities have reestablished ground-water flow to drained areas. The hypothesis that flow paths altered by drainage may be noted in the chemistry does not appear to be true. Therefore it is not worthwhile to continue chemistry sampling during the post-construction phase in expectation of observing changes in chemistry caused by restoration of flow paths. Monitoring of water chemistry will not continue.

SUMMARY

The hydrogeology and geochemistry of the Hickory Grove fen and surrounding area has been characterized, and final conclusions are presented in this report. Monitoring of the ground- and surface-water levels will continue through the post-construction phase in order to determine the performance of the restoration activities. A Final Monitoring Report will be submitted at the end of the monitoring period (normally 5 years) or earlier if required by IDOT.

Hickory Grove fen is located at the base of the slope between uplands to the south and the Fox River floodplain to the north. The uplands adjacent to and beneath the fen are composed of sand and gravel interlayered with diamicton units. The Fox River floodplain is infilled with beds of peat, clay, silt, and sand that lap onto the base of the uplands and partially overlie the fen.

Ground water flows into sediments in the Fox River floodplain (units A–D) from sand and gravel unit L within and beneath the fen. Water flows from southwest to northeast primarily through units A and C. During the monitoring period, wetlands hydrology was indicated by wells 5U, 7U, 9U, 11U, 13U, and 14U.

Ditches affect the site by draining adjacent areas and by intercepting ground-water flow. The east–west ditch intercepts northeasterly ground-water flow in peat unit A and has caused drainage of areas north of and adjacent to the ditch. Drainage caused by field tiles may also decrease residence time and levels of ground water in other areas (e.g. adjacent to wells 2 and 3).

Present wetlands in the study area are being supported by various water sources. South of the east–west ditch, wetlands are supported primarily by ground water. North of the east–west ditch, wetlands are primarily supported by surface-water influx and precipitation, although some ground-water input is likely west of the western end of the east–west ditch. Water-level data from wells screened in sandy silt unit C show that ground-water is not confined throughout most of the area north of the east–west ditch and is not capable of upward flow to unit A.

Geochemical sampling of water was performed quarterly. Surface- and ground-water samples were collected. Water samples are generally rich in calcium and magnesium, and show only minor spatial or temporal variation. No delineation of areas affected by drainage was possible. Therefore, no changes in geochemistry are expected during restoration, and no sampling will be done during the post-construction monitoring.

Potential for wetlands mitigation at this site occurs in two primary areas. In area 3, north of the east–west ditch, drainage by the ditches and interruption of ground-water flow in peat unit A occurs. Wetlands hydrology is not present in this area. Some drainage by field tiles may also occur in this area. Degraded peat and hydric soils occur in this area. Little ground-water discharge is seen in this area. Restoration of northward ground-water flow by the removal of field tiles and filling the east–west ditch west of spring run A may raise water levels in unit A. Lowered water levels also occur in area 2, south of the east–west ditch and east of spring run A, where wetland hydrology is also largely not present. In this area, field tiles and the downcutting of both spring run A and the east–west ditch cause drainage of peat unit A. Degraded peat and hydric soils occur in this area. It is recommended that the portions of east–west ditch and spring run A adjacent to this area not be manipulated due to the likelihood of construction damage to sensitive portions of the fen. Removal of the drainage tiles may increase the residence time of ground water and may raise ground-water levels sufficient to restore wetlands hydrology.

Fen hydrology is indicated by levels in wells 2L, 3L, 9L, and 11L–12L. Wells 2L and 3L occur within area 2, and do not have wetlands hydrology at present. Successful removal of drainage alterations adjacent to these wells may restore fen wetland. Area 3, north of the east–west ditch, does not have fen hydrology, and likely will not become fen if wetland hydrology is restored.

Future work at this site will include continued monitoring of ground-water levels. Detailed data regarding the water budget of the site, hydrologic parameters of the sediments onsite (i.e. hydraulic conductivity), and additional geologic borings located in key areas would be useful in clarifying the present understanding of the workings of the fen, and will be collected if possible.

ADDENDUM: 1996 RESTORATION ACTIVITIES

In February 1996, a restoration plan was implemented at this site. West of spring run A, the east–west ditch was backfilled with spoil from the original digging of the ditch. At least three, if not four, composite berms were installed across the former ditch line; these consist of a berm about 1.5 m (5 ft) wide composed of small dolomite or limestone boulders up to about

30 cm in diameter emplaced downstream of a thinner clay berm about 0.75 m (2.5 ft) in width. This composite berm acts to prevent the ditch fill from eroding and to prevent groundwater flow through the fill down the former ditch line. Field observations indicate ponding upstream of each berm, and some increased saturation in Area 3 north of the ditch. In addition, a small amount of trenching was done in Area 2, and some field tile removed. However, much field tile remains in this area and in other areas, so that this is not likely adequate to rehydrate Area 2.

Additional wells were installed in Spring 1996 adjacent to the former east–west ditch in the expected area of rehydration. These wells and the preexisting wells will be monitored monthly for a period of 5 years beyond construction, or until IDOT directs otherwise. At that time, a Final Monitoring Report will be issued detailing the hydrogeologic results of the restoration activities, including the description of any increased saturation levels after restoration.

ACKNOWLEDGMENTS

Funding for this study was provided primarily by the Illinois Department of Transportation. Additional funding was provided by the Illinois State Geological Survey. This report was reviewed by David Larson of ISGS.

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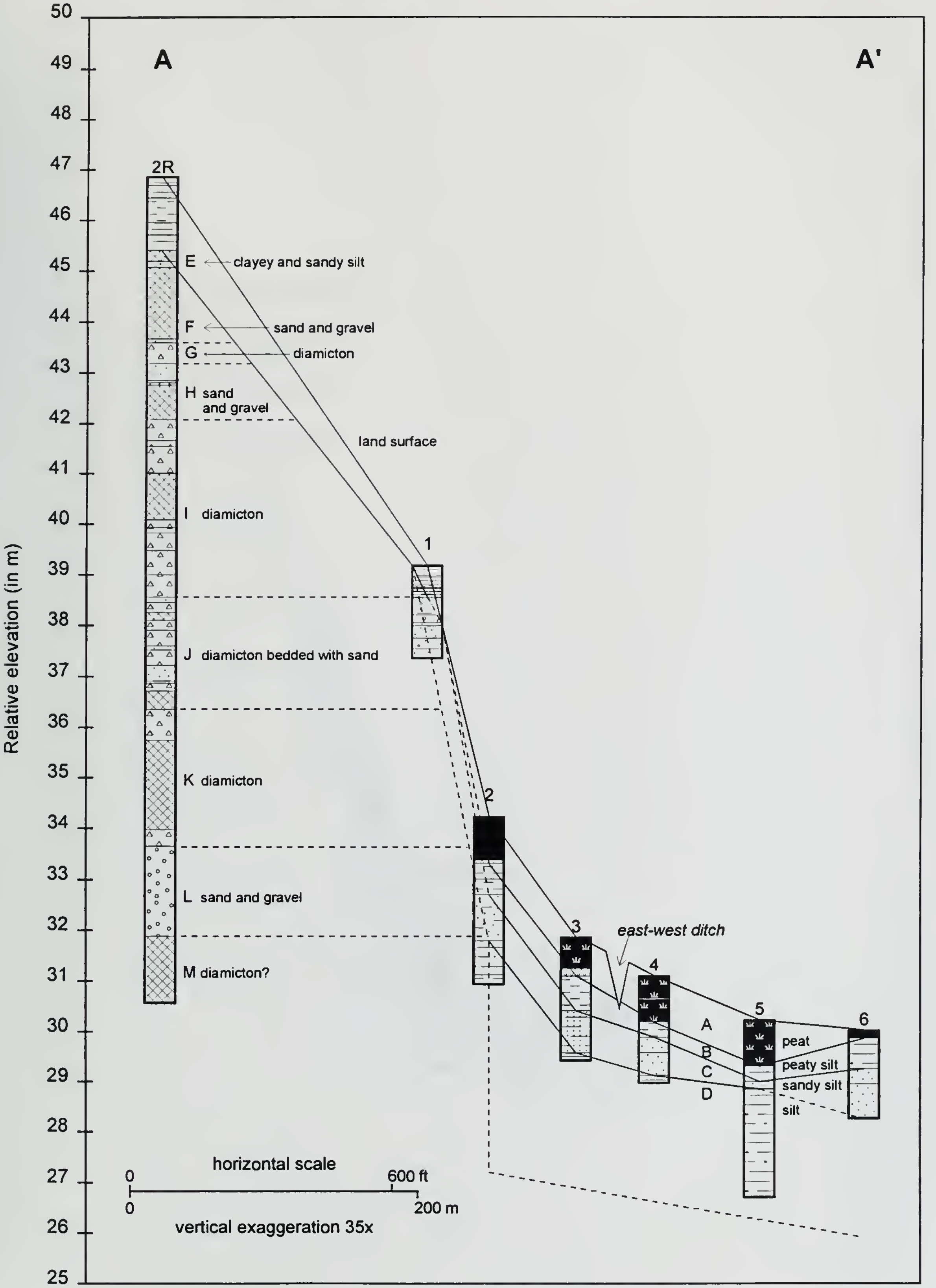
APPENDIX A Geologic Cross Sections and Logs of Borings at the Hickory Grove Site
Part 1 Index of Geologic Symbols

- Gravel (includes boulders, cobbles, pebbles, and granules)
- Gravelly sand
- Gravelly silt
- Sand
- Silty sand
- Clayey sand
- Sandy silt
- Silt
- Clayey silt
- Sandy clay
- Silty clay
- Clay
- Diamicton
- Peat
- Muck
- Organic material
- Marl
- No recovery

APPENDIX A *continued*

Part 2 Geologic Cross Sections (lines of cross section in figure 3)

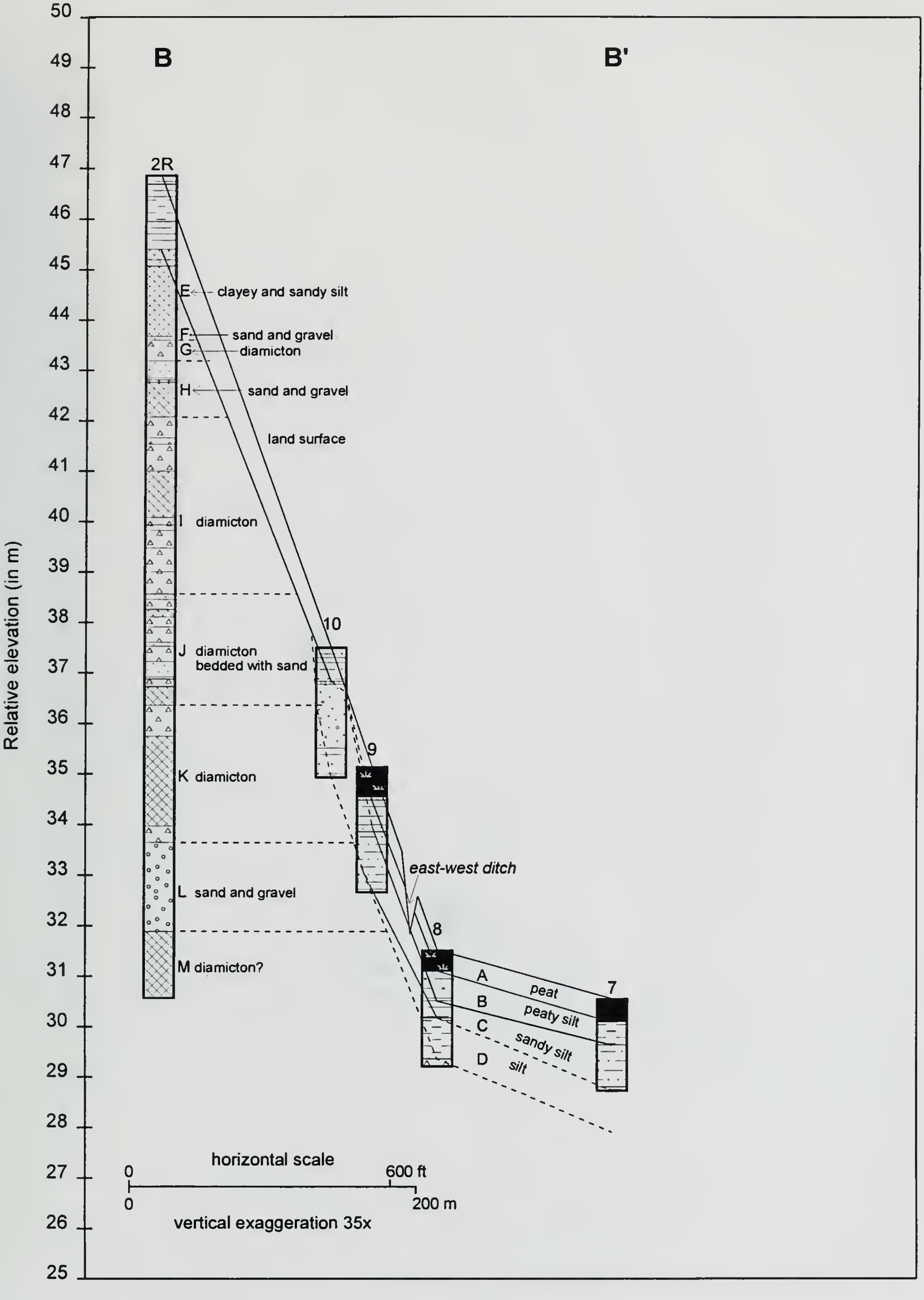
CROSS SECTION A–A′



APPENDIX A *continued*

Part 2 Geologic Cross Sections (lines of cross section in figure 3)

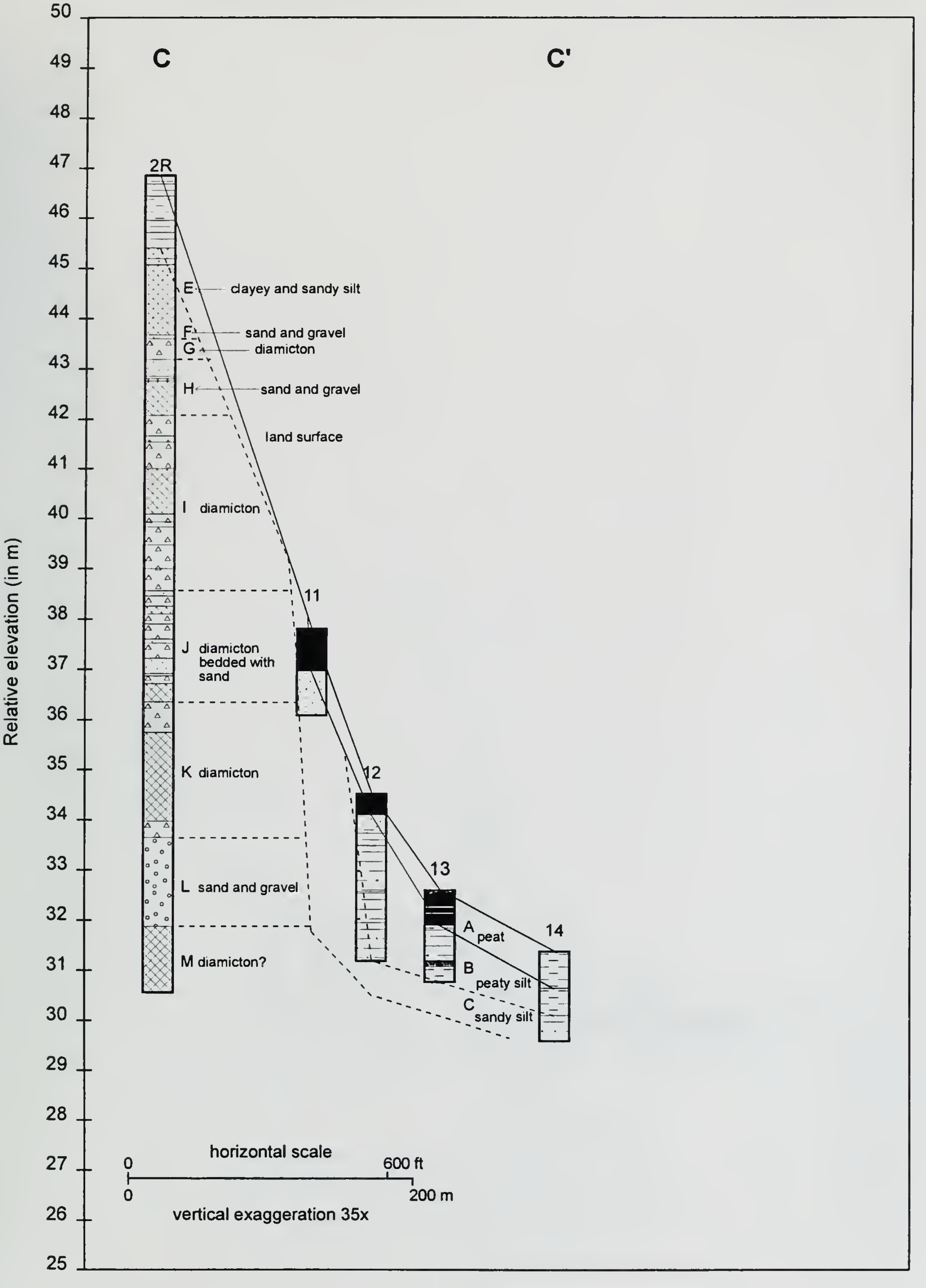
CROSS SECTION B–B′



APPENDIX A *continued*

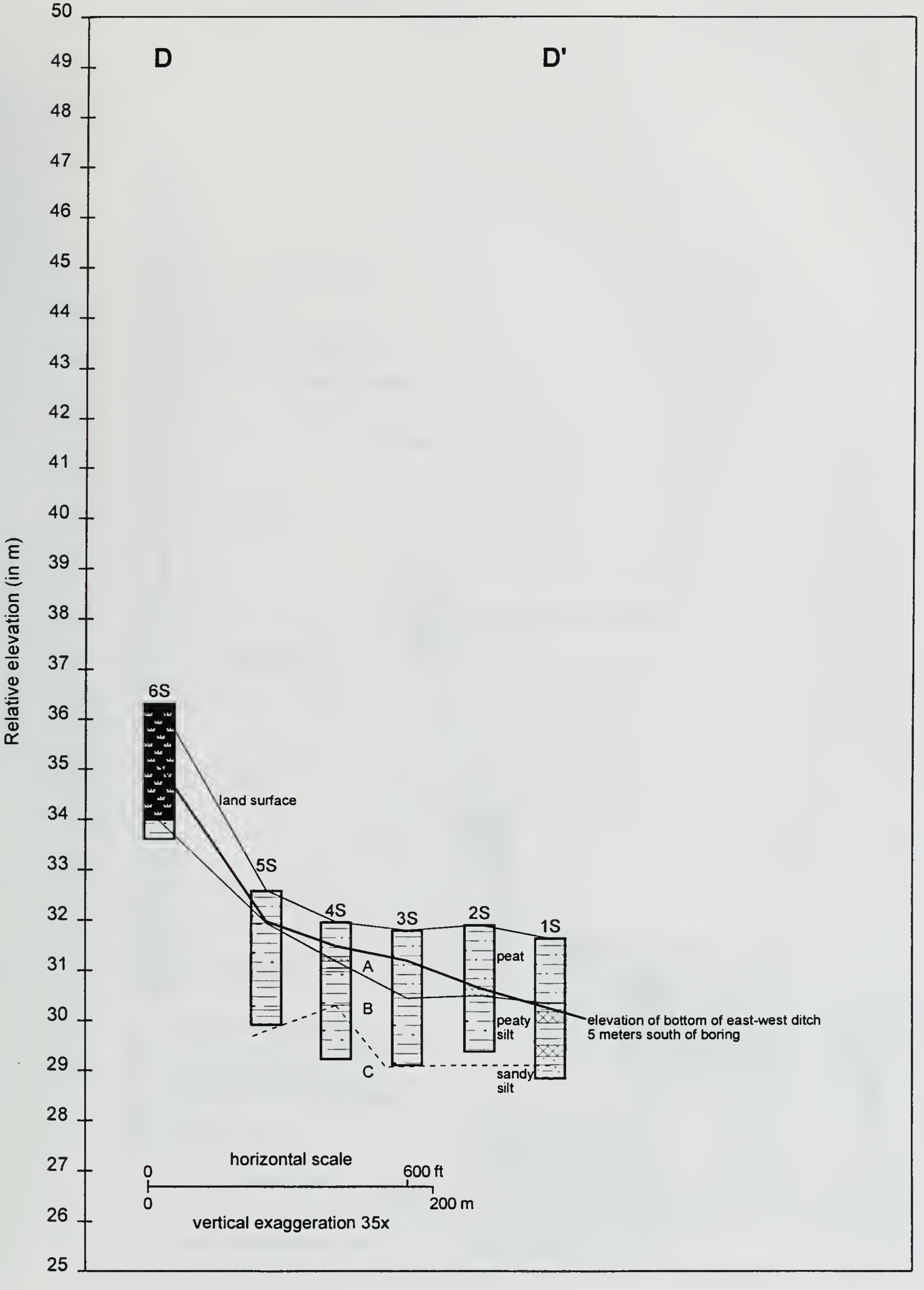
Part 2 Geologic Cross Sections (lines of cross section in figure 3)

CROSS SECTION C–C′



APPENDIX A *continued*
Part 2 Geologic Cross Sections (lines of cross section in figure 3)

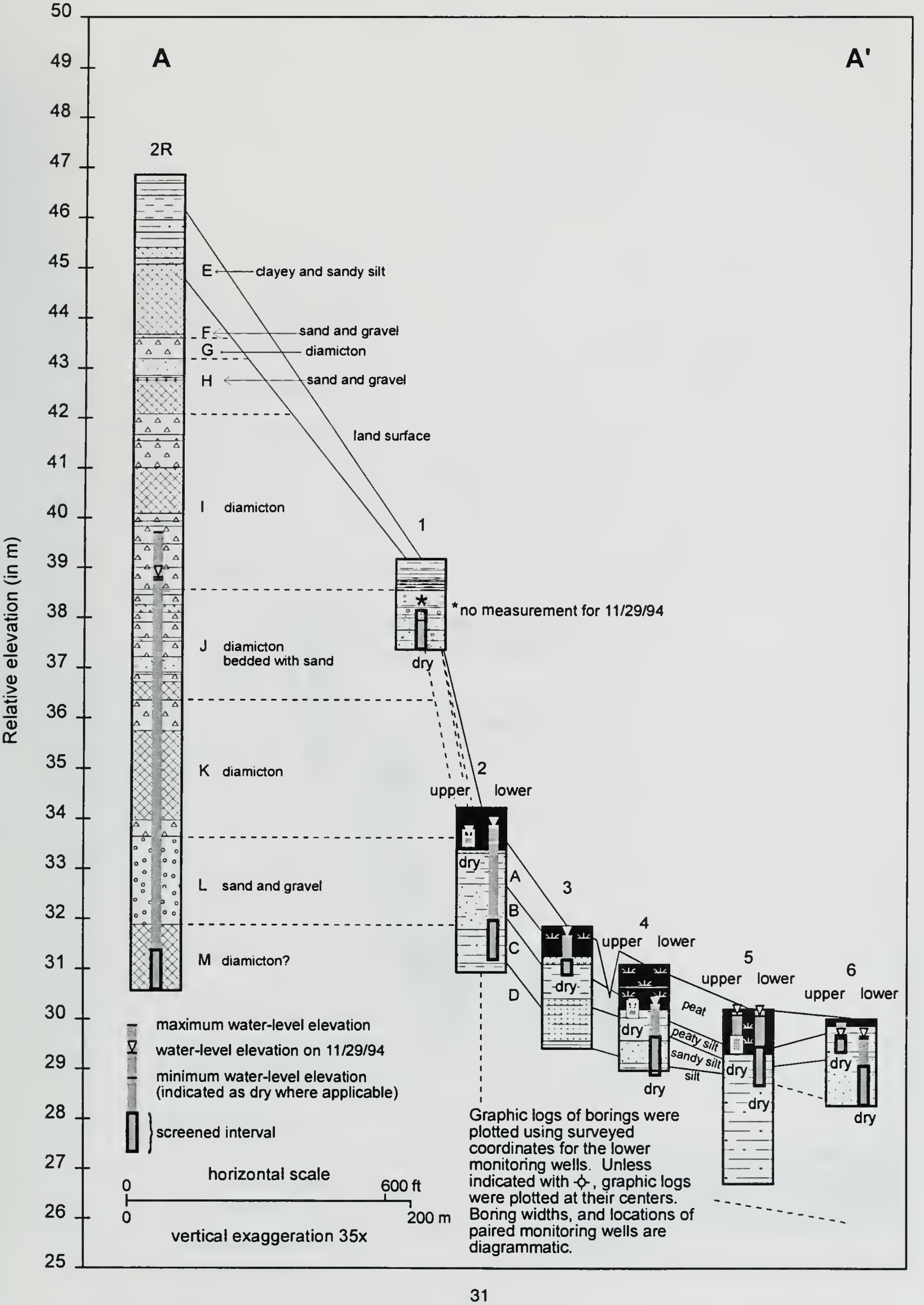
CROSS SECTION D–D′



APPENDIX A *continued*

Part 3 **Cross Sections with Well Diagrams** (lines of cross section in figure 3)

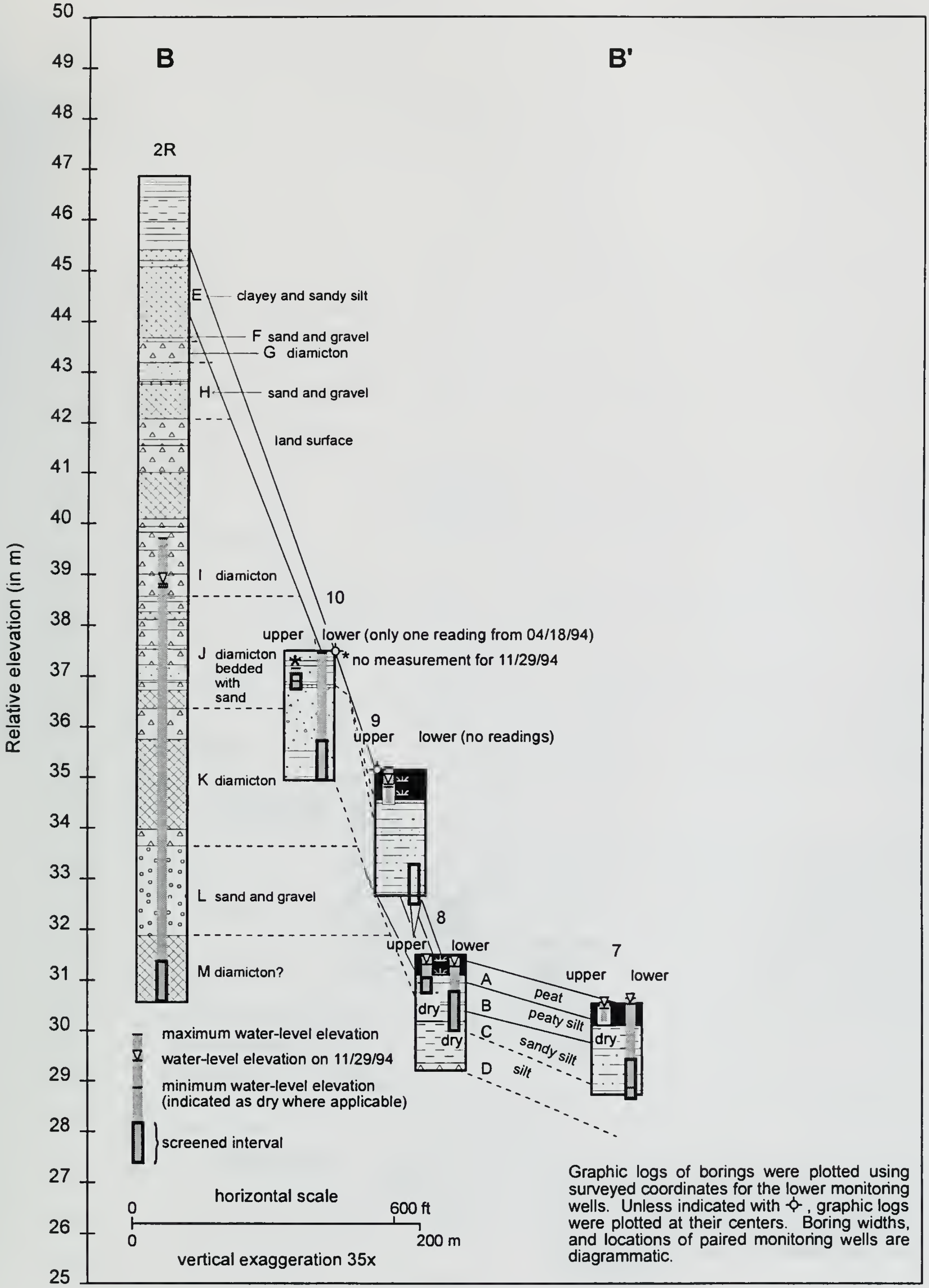
CROSS SECTION A–A′



APPENDIX A *continued*

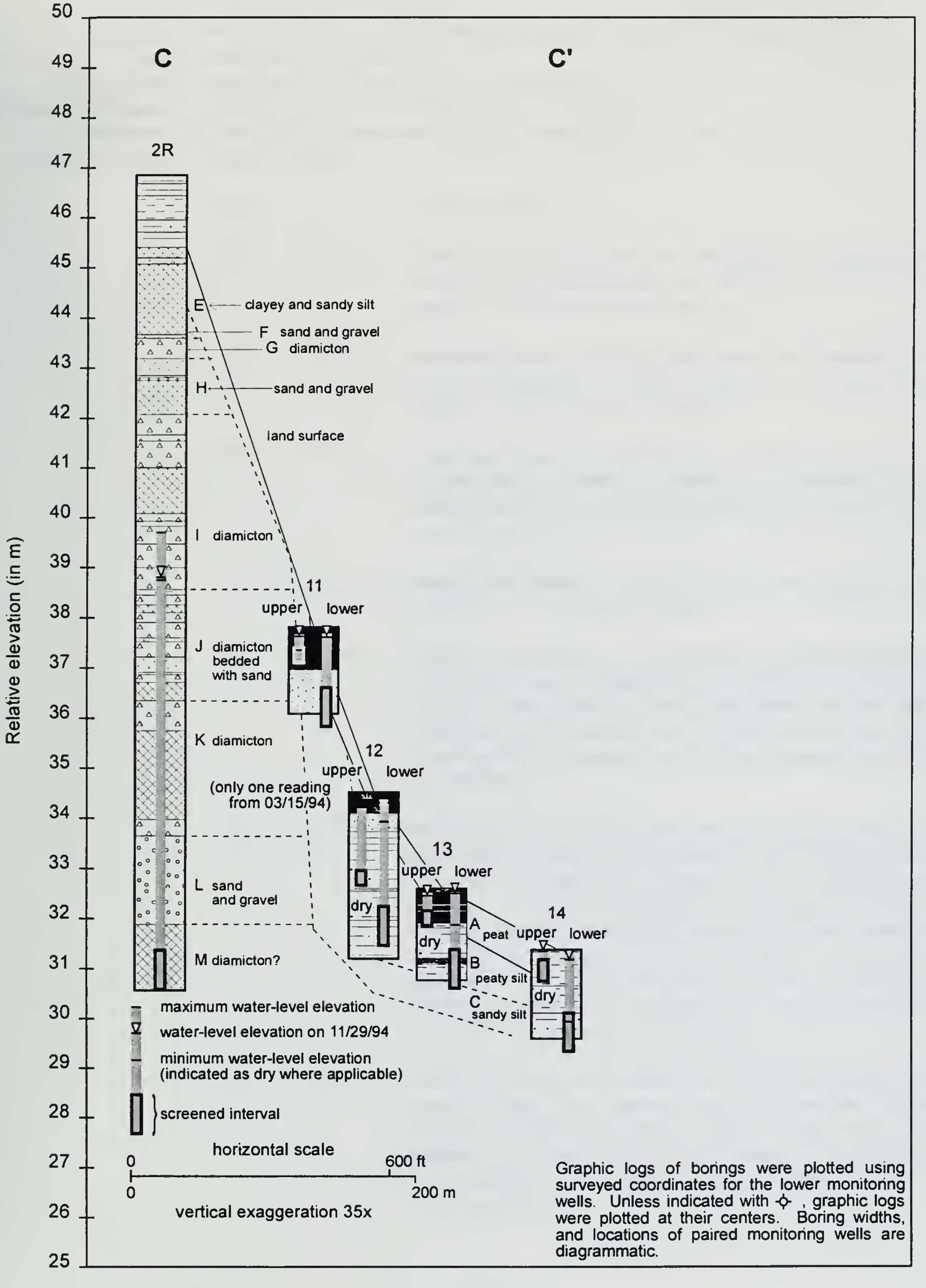
Part 3 Cross Sections with Well Diagrams (lines of cross section in figure 3)

CROSS SECTION B–B′



APPENDIX A *continued*
Part 3 Cross Sections with Well Diagrams (lines of cross section in figure 3)

CROSS SECTION C–C′



Graphic logs of borings were plotted using surveyed coordinates for the lower monitoring wells. Unless indicated with ⌖, graphic logs were plotted at their centers. Boring widths, and locations of paired monitoring wells are diagrammatic.

Part 4 Geologic Logs of Borings

HICKORY GROVE #1R

Location	NW SW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date	12/14/93 and 12/15/93
Field Crew	James Neal, Christine Fucciolo, James Miner
Weather Conditions	Cloudy and rainy on 12/14/93; partly sunny on 12/15/93
Comments	Mobile drill rig, hollow-stem auger, continuous 1.5-m (5-ft) sampler
Well Information	No wells installed

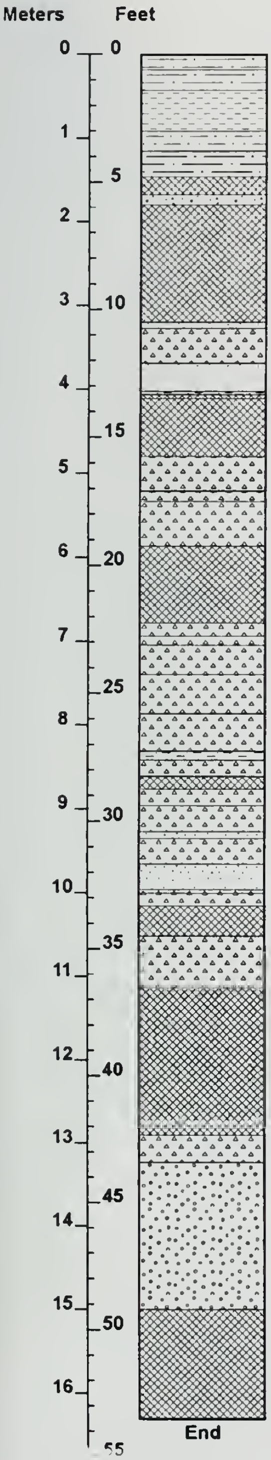
Depth	**Unit Descriptions**
0.00 – 0.08 m	**Sandy silt;** black (10YR 2/1); rooty; approximately 10% is visible roots; noncalcareous to weakly calcareous; crumb structure. Gradual lower contact to:
0.08 – 0.13 m	**Sandy silt;** black (10YR 2/1); rare roots; rare dolomite granules 2.5 mm in diameter; weakly calcareous; no visible structure. Sharp, convoluted lower contact to:
0.13 – 0.18 m	**Sandy silt;** dark yellowish brown (10YR 4/4); some clay; noncalcareous to weakly calcareous; rare granules 2.5 mm in diameter; some dark brownish burrow fills and blebs. Sharp lower contact to:
0.18 – 0.25 m	**Sandy silt;** similar to 0.08–0.13 m, but granitic pebbles 10 to 30 mm in diameter present.
0.25 – 0.33 m	**Gravel;** brown (10YR 4/3); clast supported; approximately 20% is granules; approximately 30% is pebbles up to 30 mm in diameter; about 20% is sand; less than 10% is clay; the remainder of the deposit is silt; clasts are subrounded and consist mainly of dolomite, but chert and greenish granitics are also present.
0.33 – 2.31 m	**No recovery.** Center-bit drilled through gravel. Between 0.33 and 1.52 m, cuttings are similar to gravel described for 0.25–0.33 m. Between 1.52 and 1.68 m, cuttings consist of pebbles up to 5 mm in diameter. Between 1.68 and 1.83, cuttings coarsen and again are similar to gravel described for 0.25–0.33 m. Between 1.83 and 1.98 m, cuttings fine to pebbles up to 5 mm in diameter. Between 1.98 and 2.31 m, cuttings coarsen and are similar to gravel described for 0.25–0.33 m. Resumed sampling at 2.31 m.
2.31 – 2.69 m	**Gravel;** yellowish brown (10YR 5/4); dry; clast supported; clasts range in size from medium sand to pebbles 10 mm in diameter; approximately 50% is gravel of dolomite, greenish granitics and chert; about 40% is sand; about 10% is silt; highly calcareous, but possibly due to dolomitic powder from center-bit drilling.

Depth	Unit Descriptions
2.69 – 2.82 m	**Sand;** brownish; clast supported; dry; clean; weakly calcareous; sand is medium to coarse, moderately sorted, and angular to rounded; granules present; about 5% is rounded pebbles of dolomite and greenish granitics up to 10 mm in diameter.
2.82 – 2.97 m	**Sand;** tannish; clast supported; laminated; dry; weakly calcareous; sand is fine to medium, well sorted, and angular to rounded; laminated by color only at 1- to 2-mm intervals.
2.97 – 3.20 m	**Gravel;** dry; rounded; gravel ranges in size from 2.5 to 20 mm in diameter and consists of dolomite and granitics; some fine sand present; sand is rounded to angular and consists of quartz, dolomite and granitics.
3.20 – 4.22 m	**No recovery.**
4.22 – 4.42 m	**Gravel;** similar to 2.97–3.20 m.
4.42 – 4.65 m	**No recovery.** Cuttings consist of gravel.
4.65 – 6.71 m	**No recovery.** Center-bit drilling through gravel. At 5.05 m, cuttings consist of pebbles and cobbles between 50 and 100 mm in diameter; gravel is well rounded, sorted, clean, dry, and consists of dolomite and granitics. At 6.10 m, cuttings fine to pebbles less than 10 mm in diameter. Resumed sampling at 6.71 m.
6.71 – 6.91 m	**Gravel;** sandy; gravel is moderately sorted, rounded and consists of dolomite, granitic and basaltic pebbles less than 20 mm in diameter; sand is medium-grained.
6.91 – 7.26 m	**No recovery.**
7.26 – 7.59 m	**Gravelly sand;** brownish; weakly calcareous; sand is medium to coarse, poorly sorted, angular to rounded and consists of quartz, dolomite and granitic grains; granules and pebbles up to 10 mm in diameter comprise about 10–20%; gravel is rounded and consists of dolomite and granitics.
7.59 – 8.31 m	**No recovery.** Wet at 8.31 m.
8.31 – 8.53 m	**Sand;** coarse-grained with granules; weakly calcareous; moderately sorted; subrounded; grains consist of quartz, dolomite and granitics; no visible structure. Sharp lower contact to:
8.53 – 8.71 m	**Sand;** brownish; fine; calcareous; possibly very slight laminae of coarse silt present. Gradual lower contact to:

Depth	Unit Descriptions
8.71 – 8.79 m	**Silt;** light brownish; laminated; calcareous; laminae are 0.1 mm thick, consist of finer material in a coarser matrix, and are spaced at 3-mm intervals.
8.79 – 11.05 m	**No recovery.** Center-bit drilling due to blow in. Near 8.84 m, cuttings consist of rounded dolomite cobbles 100 to 150 mm in diameter. Near 10.31 m, driller reports lack of gravel. Resumed sampling at 11.05 m.
11.05 – 11.58 m	**Diamicton;** sandy loam texture; dark gray (10YR 4/1); calcareous; matrix supported; approximately 10% is clasts of granules and pebbles between 2.5 and 5 mm in diameter; clasts consist of dolomite, chert, basaltics, and greenish fine-grained rock fragments; clasts are bullet-shaped and striated; possibly some preferred clast orientation; some coarse sand in matrix; no visible structure or lamination; between 11.05 and 11.20 m, deposit is wetter and softer; below 11.20 m, deposit is drier, moderately stiff and highly calcareous.
11.58 – 11.89 m	**No recovery.**
11.89 – 12.01 m	**Diamicton;** similar to 11.05–11.58 m, but brown (7.5YR 5/2). Gradual lower contact to:
12.01 – 12.37 m	**Silty sand;** grayish; moderately calcareous; clast supported.
12.37 – 12.50 m	**Diamicton;** loam texture; brown (7.5YR 5/2); moderately stiff; moist; approximately 5 to 10% is clasts of granules and pebbles between 2.5 and 5 mm in diameter; clasts consist of dolomite, shale and crystallines; clasts are glacially carved. Sharp lower contact to:
12.50 – 12.65 m	**Gravelly sand;** clast supported; laminated at 2- to 5-mm intervals; moderately to weakly calcareous; sand is moderately sorted; gravel is granule-sized; grains are comprised of quartz, dolomite, reddish siltstone, shale, and crystallines. Sharp lower contact to:
12.65 – 12.93 m	**Diamicton;** similar to 12.37–12.50 m, but contains a layer of fine grayish sand 10 mm thick at 12.85 m.

HICKORY GROVE #2R

Location	NE SE SW Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date	12/16/93 and 12/17/93
Field Crew	James Neal, Christine Fucciolo, James Miner
Weather Conditions	Cloudy, drizzly, 40°F
Comments	Mobile drill rig, hollow-stem auger, continuous 1.5-m (5-ft) sampler
Well Information	One well installed; construction information in Appendix B



Depth	Unit Descriptions
0.00 – 0.18 m	**Clayey silt;** very dark grayish brown (10YR 3/2); rooty; noncalcareous; no visible structure. Gradual lower contact over 2.54 cm (1 in.) to:
0.18 – 0.43 m	**Clayey silt;** yellowish brown (10YR 5/4); very weakly calcareous; very fine crumb structure; some roots present; rare angular dolomite pebbles 5 to 10 mm in diameter. Gradual lower contact to:
0.43 – 0.91 m	**Silty clay;** brown (10YR 4/3); weakly calcareous; rooty; fine subangular blocky peds; dark brownish clay skins on peds. Sharp lower contact to:
0.91 – 1.17 m	**Clayey sand;** yellowish brown (10YR 5/6); clast supported; very porous; degraded dolomite granules up to 2 mm in diameter present; dark clay skins around roots. Gradual lower contact to:
1.17 – 1.47 m	**Clayey silt;** bedded with sandy silt and sand; clayey silt is brown (10YR 5/4), calcareous and is laminated and mottled pale brown (10YR 6/3); sandy silt is yellowish brown (10YR 5/6), weakly calcareous, with fine sand grains and rare granules; sand is yellowish brown (10YR 5/6), fine- to medium-grained, poorly sorted, angular, and noncalcareous.
1.47 – 1.68 m	**No recovery.**
1.68 – 1.80 m	**Gravelly sand;** sand is noncalcareous, medium, poorly sorted, with grains ranging in size from fine to coarse; sand grains are angular and consist of quartz, dolomite, basaltics, and shale; pebbles are rounded, poorly sorted and are between 2.5 and 40 mm in diameter; pebbles have striae.
1.80 – 3.20 m	**No recovery.** Center-bit drilling through gravel.
3.20 – 3.28 m	**Sand;** brownish; medium- to coarse-grained; dry; calcareous to noncalcareous; moderately sorted; subrounded; grains consist of quartz, dolomite and some exotics; some rounded to angular dolomite granules 2.5 mm in diameter. Sharp lower contact to:

Depth	Unit Descriptions
3.28 – 3.68 m	**Diamicton;** loam texture; light yellowish brown (10YR 6/4); highly calcareous; very faint platy structure; approximately 5% is clasts between 1 and 10 mm in diameter. Sharp lower contact to:
3.68 – 4.01 m	**Sand;** light brownish; medium; moderately sorted; rounded to angular; calcareous; grains consist of quartz, dolomite, reddish siltstone and greenish rock fragments; possibly slightly laminated in 10-mm intervals; between 3.68 and 3.78 m, cleaner sand alternates with more clay-rich sand in 10- to 30-mm layers.
4.01 – 4.06 m	**Silty sand;** light yellowish brown (10YR 6/4); calcareous; laminated; laminae are 1 mm thick and occur in 2.5-mm intervals; sand is fine-grained; rare dolomite pebbles 5 mm in diameter; one rounded dolomite pebble 30 mm in diameter.
4.06 – 4.11 m	**No recovery.**
4.11 – 4.80 m	**No recovery.** Center-bit drilling.
4.80 – 5.21 m	**Diamicton;** loam to clay loam texture; yellowish brown (10YR 5/4); calcareous; porous; almost clast supported; moist; slightly stiff; approximately 5% is clasts composed of dolomite, reddish siltstone, quartzite, shale and basaltics up to 30 mm in diameter; no visible structure. Sharp lower contact to:
5.21 – 5.33 m	**Diamicton;** similar to 4.80–5.21 m, but yellowish brown (10YR 6/4); highly calcareous; stiff. By 5.28 m, becomes moist, saturated, very sandy and pebbly. Sharp lower contact to:
5.33 – 5.87 m	**Diamicton;** loam texture; brown (7.5YR 5/4); calcareous; moist; slightly stiff; approximately 5 to 10% is clasts up to 30 mm in diameter consisting of dolomite, gneiss, granitics, shale and blackish basaltics; clasts possibly imbricated; slightly porous; possibly clast supported, but some matrix evident.
5.87 – 6.78 m	**No recovery.** Center-bit drilling. Cuttings consist of gravel. Driller reports softer material at 6.63 m. Resumed sampling at 6.78 m.
6.78 – 6.93 m	**Diamicton;** loam texture; grayish brown (10YR 5/2); approximately 5% is clasts up to 10 mm in diameter; no visible structure. Gradual lower contact to:

HICKORY GROVE #2R *continued*

Depth	Unit Descriptions
6.93 – 7.04 m	**Diamicton;** loam texture; gray (10YR 5/1); slightly stiff; almost saturated; more pebbly than 6.78–6.93 m with approximately 10% clast content. Gradual lower contact to:
7.04 – 7.39 m	**Diamicton;** same as 6.78–6.93 m.
7.39 – 7.87 m	**Diamicton;** similar to 6.78–6.93 m, but moist. At 7.82 m, large granitic and dioritic rock was encountered with auger, ground up and brought up borehole as cuttings.
7.87 – 8.31 m	**Diamicton;** similar to 6.78–6.93 m, but moist. Between 8.26 and 8.31 m, more stiff, more grayish and more clay-rich . Sharp lower contact to:
8.31 – 8.41 m	**Silty sand;** light brownish layer 5 mm thick at upper contact, gray (10YR 5/1) below that; poorly sorted with grains as large as granules; moist; weakly calcareous; possibly clast supported; weakly laminated by grain size in 1-mm intervals. Gradual lower contact to:
8.41 – 8.61 m	**Diamicton;** silt loam texture; grayish brown (2.5Y 5/2); highly calcareous; dry; approximately 1% is clasts of dolomite and shale up to 10 mm in diameter; no visible structure; one 50-mm diameter dolomite pebble at upper contact.
8.61 – 8.76 m	**No recovery.**
8.76 – 8.97 m	**Diamicton;** same as 8.41–8.61 m.
8.97 – 9.27 m	**Diamicton;** silt loam texture; laminated in 10-mm intervals by color with gray (10YR 5/1) alternating with grayish brown (10YR 5/2); moist; calcareous; approximately 1% is clasts of dolomite, shale and crystallines up to 5 mm in diameter; discrete sand layers between 9.12 and 9.14 m and 9.17 and 9.19 m; sand is brownish, saturated, calcareous, rounded to angular, and poorly sorted with grains as large as granules. Sharp lower contact to:
9.27 – 9.35 m	**Sand;** dark brownish; saturated; poorly sorted; angular to rounded; grains consist of quartz, dolomite, shale, and crystallines. Laminated lower contact over 2.54 cm to:
9.35 – 9.65 m	**Diamicton;** silt loam to loam texture; grayish brown (10YR 5/2); moist; no visible structure; approximately 5% is clasts up to 20 mm in diameter of dolomite, shale and crystallines.

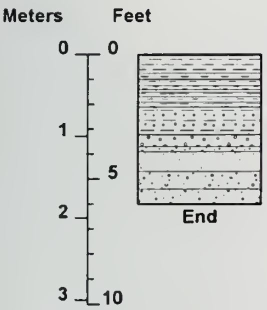
HICKORY GROVE #2R *continued*

Depth	Unit Descriptions
9.65 – 9.96 m	**Sand;** grayish; medium; sorted; saturated; clast supported; subrounded to subangular; grayish, diamicton-like, clay- and silt-rich body with discrete boundaries between 9.73 and 9.83 m.
9.96 – 10.01 m	**Diamicton;** loam texture; grayish; moist; slightly stiff; no visible structure; approximately 5% is pebbles.
10.01 – 10.11 m	**Diamicton;** loam texture; grayish brown (10YR 5/2); calcareous; no visible structure; approximately 5% is pebbles of dolomite, shale and crystallines.
10.11 – 10.52 m	**No recovery.** Sample consists of sandy material.
10.52 – 10.72 m	**Diamicton;** loam texture; grayish brown (5/2); moderately calcareous; no visible structure; approximately 1 to 5% is clasts.
10.72 – 11.13 m	**Diamicton;** loam texture; dark grayish brown (10YR 4/2); highly calcareous; slight platy appearance; possibly laminated by color; approximately 5% is clasts up to 20 mm in diameter of dolomite, shale and crystallines.
11.13 – 12.90 m	**No recovery.** Center-bit drilling due to sand blow-in and rock. Resumed sampling at 12.90 m.
12.90 – 13.23 m	**Diamicton;** loam to sandy loam texture; brown (7.5YR 4/2); approximately 10% is clasts between 1 and 2 mm in diameter of dolomite, shale, crystallines and red siltstone; stiff; calcareous; no structure noted; moist; nonsaturated.
13.23 – 15.00 m	**Gravel;** granules and pebbles between 2.5 and 10 mm in diameter; well rounded; assorted lithologies.
15.00 – 16.31 m	**No recovery.** Driller reports probable diamicton.

APPENDIX A *continued*
Part 4 Geologic Logs of Borings

HICKORY GROVE #1

Location NE SW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date 11/08/93
Field Crew Christine Fucciolo, James Miner, Wayne Schennum (MCCD)
Weather Conditions Sunny
Comments Drilled with bucket auger
Well Information One well installed; construction information in Appendix B



Depth		Unit Descriptions
0.00 –	0.23 m	**Silt;** black; organic-rich; approximately 10% is clay; some fine sand.
0.23 –	0.30 m	**Sandy silt;** brown (10YR 4/3); some organics; rare granule 2.5 mm in diameter.
0.30 –	0.38 m	**Sandy silt;** dark grayish brown (10YR 4/2); some clay; approximately 10% is granules of chert and sandstone less than 2.5 mm in diameter; noncalcareous.
0.38 –	0.43 m	**Silty sand;** brown (10YR 4/3); approximately 10% is granules less than 2.5 mm in diameter of primarily sandstone, with crystallines and chert; noncalcareous.
0.43 –	0.46 m	**Silty sand**; very dark grayish brown (10YR 3/2); about 10% is clay; about 10% is granules and pebbles.
0.46 –	0.52 m	**Sandy clay**; greater than 30% is clay; about 10% is pebbles and granules.
0.52 –	0.58 m	**Silty clay;** some fine sand; some sandstone pebbles about 10 mm in diameter.
0.58 –	0.64 m	**Sandy clay**; brown (10YR 4/3); about 10% is pebbles of sandstone, dolomite and some crystallines up to 20 mm in diameter; slightly calcareous.
0.64 –	0.98 m	**Gravelly silt;** yellowish brown (10YR 5/4); approximately 20% is pebbles and granules of mostly dolomite up to 10 mm in diameter; sandy; no structure; slightly calcareous; becomes more pebbly (approximately 30% dolomitic pebbles) and clay rich at 0.82 m; near base, approximately 60% is dolomitic pebbles.
0.98 –	1.13 m	**Gravel;** brown (10YR 5/3); about 70% is granules and pebbles in a sandy clay matrix; poorly sorted; subrounded grains; granules comprise the majority of the gravel and are mostly dolomitic and less than 2.5 mm in diameter; pebbles are mostly dolomitic and up to 10 mm in diameter.

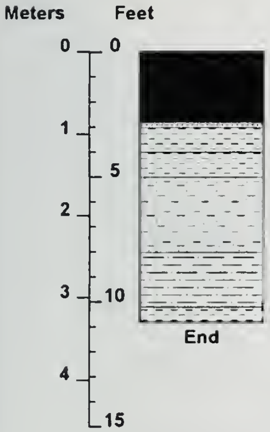
HICKORY GROVE #1 *continued*

Depth	Unit Descriptions
1.13 – 1.19 m	**Gravelly sand;** yellowish brown (10YR 5/4); about 20% is granules less than 2.5 mm in diameter.
1.19 – 1.43 m	**Sand;** brownish yellow (10YR 6/6); fine; moist; bedded by color and grain size; calcareous; about 5% is granules 2.5 mm in diameter; mottled from 1.31 m.
1.43 – 1.65 m	**Gravelly sand;** brownish yellow (10YR 6/6); saturated; calcareous; sand is fine-grained; granules are less than 2.5 mm in diameter and are sorted and subangular.
1.65 – 1.82 m	**Gravelly sand;** approximately 20% is granules and pebbles of dolomite up to 10 mm in diameter; sand is coarse-grained, poorly sorted and rounded.

APPENDIX A *continued*
Part 4 Geologic Logs of Borings

HICKORY GROVE #2

Location NE SW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date 11/09/93
Field Crew Christine Fucciolo, James Miner, Wayne Schennum and Brad Woodson (MCCD)
Weather Conditions 35°F, sunny, light winds
Comments Drilled with bucket auger
Well Information Two wells installed; construction information in Appendix B

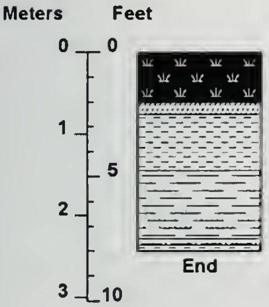


Depth	Unit Descriptions
0.00 – 0.85 m	**Muck;** black (N 2.5/); organic; dry; degraded; calcareous; rooty; little to no clastics; increasing consolidation with depth; some gastropod shells less than 2.5 mm in diameter; rare sand grains which are angular quartz.
0.85 – 0.91 m	**Marl;** light gray (10YR 7/2); calcareous; $CaCO_3$ grains are crushable, porous and possibly bedded with preserved leaves.
0.91 – 1.22 m	**Silty clay;** dark gray (2.5Y 4/1); noncalcareous to poorly calcareous; about 10% is visible organic matter consisting of leaves and possibly cattail remains; some clastics consisting of fine sand or silt present; gastropod shells 1–2 mm in diameter noted; H_2S odor; not spongy.
1.22 – 1.52 m	**Silty clay;** very dark gray (2.5Y 3/1); stiff; about 5% is visible organic material including woody fragments; layered appearance; not spongy.
1.52 – 2.44 m	**Silty sand;** dark gray (2.5Y 4/1); approximately 40% is sand which is medium-grained, poorly sorted and subangular; organic layers present; at 1.68 m, grades to about 80% sand which is fine to coarse, poorly sorted, rounded, gray (2.5Y 5/1), very wet and contains less than 5% organic material; at 2.10 m, appears bedded by grain size and color (brownish yellow/gray) with beds 5 mm thick consisting of quartz, potassium feldspars and rock fragments; at 2.24 m, grades to brownish yellow (10YR 6/8), noncalcareous, medium to coarse sand with sorted and rounded to well rounded grains of quartz, potassium feldspars, rock fragments and possibly dolomite.
2.44 – 3.11 m	**Silt;** dark gray (2.5Y 4/1); some fine sand; noncalcareous; between 2.36 and 2.51 m, laminated with above unit at 10-mm thick intervals; structureless; grades into:
3.11 – 3.29 m	**Silty clay;** yellowish brown (10YR 5/4); very stiff; structureless.

APPENDIX A *continued*
Part 4 **Geologic Logs of Borings**

HICKORY GROVE #3

Location NE SW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date 11/23/93
Field Crew Mark Hart, James Miner
Weather Conditions Cloudy, winds 10 MPH, 45°F
Comments Drilled with bucket auger
Well Information One well installed; construction information in Appendix B



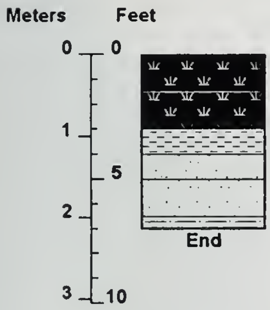
Depth	Unit Descriptions
0.00 – 0.61 m	**Peat;** black (N 2.5/); slightly elastic; moist; rooty; calcareous; approximately 1–5% is visible organic matter; about 1% is shell fragments. Sharp lower contact to:
0.61 – 0.76 m	**Marl;** light gray (10YR 7/2); calcareous; saturated; sandy silt texture.
0.76 – 1.45 m	**Silty clay;** dark gray (5Y 4/1); noncalcareous to poorly calcareous; approximately 5–10% is preserved plant fragments; about 10–15% is woody fragments; contains hard silty inclusions which are noncalcareous; H_2S odor; grades slightly browner, denser and more elastic toward base.
1.45 – 2.29 m	**Sandy clay;** gray (5Y 5/1); matrix supported; sand is medium-grained and subrounded to rounded; some parts are very sandy and clast supported with clasts consisting of quartz and rock fragments; noncalcareous except for fragments of dolomite and limestone; at 1.83 m, grades to medium sand with laminae of silty clay.
2.29 – 2.36 m	**Silt;** gray (10YR 5/1); nonlaminated to poorly laminated; about 1% is granules and pebbles of dolomite and shale 2–5 mm in diameter; less than 1% is organic matter. Grades to:
2.36 – 2.44 m	**Silty clay;** grayish brown (10YR 5/2); tight; dense; structureless; calcareous.

APPENDIX A *continued*

Part 4 Geologic Logs of Borings

HICKORY GROVE #4

Location NE SW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date 11/23/94
Field Crew Mark Hart, James Miner
Weather Conditions Sunny, winds 10 MPH, 55°F
Comments Drilled with bucket auger
Well Information Two wells installed; construction information in Appendix B

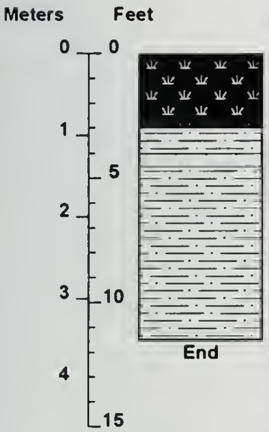


Depth		Unit Descriptions
0.00 –	0.46 m	**Peat;** black (N 2.5/); organic; shelly; dry; rooty; calcareous. Gradual lower contact to:
0.46 –	0.91 m	**Peat;** marly; very dark gray (N 3/); approximately 15–25% is gastropod shell fragments. Gradual lower contact to:
0.91 –	1.22 m	**Silty clay;** light olive gray (5Y 6/2); weakly calcareous; structureless. Grades into:
1.22 –	1.52 m	**Sand;** light olive gray (5Y 6/2); medium-grained; clast supported; subrounded; sorted; grains are quartz, dolomite and reddish rock fragments; contains silty clay lenses with organic material which are almost peaty.
1.52 –	1.98 m	**Sand;** brownish; fine to medium; sorted; subrounded; noncalcareous; grains are quartz, dolomite and crystalline rock fragments.
1.98 –	2.13 m	**Silt;** grayish.

APPENDIX A *continued*
Part 4 **Geologic Logs of Borings**

HICKORY GROVE #5

Location NE SW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date 11/23/93
Field Crew Mark Hart, James Miner
Weather Conditions Partly cloudy, winds 5–10 MPH, 55°F
Comments Drilled with bucket auger
Well Information Two wells installed; construction information in Appendix B

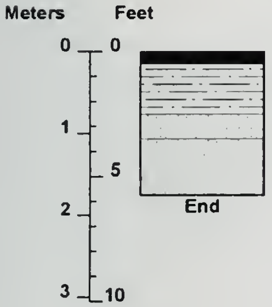


Depth		Unit Descriptions
0.00 –	0.91 m	**Peat;** black (N 2.5/); organic; 1–5% is visible organic fragments; calcareous; approximately 1% is shell fragments; water present at 0.15 m.
0.91 –	1.22 m	**Clayey silt;** olive gray (5Y 5/2); some sand and granules less than 2.5 mm in diameter present in lenses or discretely in deposit; grades into sandy clay at 1.07 m; organic material present; noncalcareous to weakly calcareous; matrix supported.
1.22 –	1.37 m	**Sand;** brownish; medium-grained; poorly sorted; subrounded; noncalcareous; some granules up to 3.5 mm in diameter consisting of dolomite, shale, quartz and red siltstone. Sharp contact to:
1.37 –	3.51 m	**Clayey silt;** olive gray (5Y 5/2); contains wood fragments; pale olive (5Y 6/4) near wood fragments; very stiff; grades to only olive gray (5Y 5/2) by 1.98 m where wood fragments are absent and deposit becomes much stiffer; no visible structure; calcareous.

APPENDIX A *continued*
Part 4 **Geologic Logs of Borings**

HICKORY GROVE #6

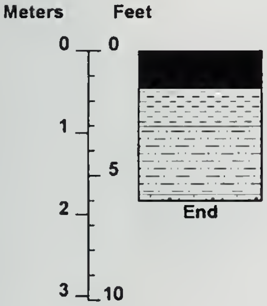
Location	SE NW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date	11/24/93
Field Crew	Mark Hart, James Miner
Weather Conditions	Cloudy, winds 10–15 MPH, 35°F
Comments	Drilled with bucket auger
Well Information	Two wells installed; construction information in Appendix B



Depth	**Unit Descriptions**
0.00 – 0.15 m	**Muck;** black (N 2.5/); organic; silty clay texture; rooty; slightly platy structure; noncalcareous.
0.15 – 0.76 m	**Clayey slit;** dark gray (2.5Y 4/1); mottled brownish yellow (10YR 6/8) in root zones; some fine sand; grades to clayey sand which is fine- to medium-grained by 0.76 m.
0.76 – 1.07 m	**Sand;** medium; grayish-brownish; clast supported; subangular; subrounded; sorted; grains consist of quartz, dolomite, reddish siltstone and rock fragments; noncalcareous.
1.07 – 1.75 m	**Sand;** poorly sorted; about 5% is dolomitic gravel up to 40 mm in diameter; sand grains include many dolomitic fragments.

HICKORY GROVE #7

Location SW NW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date 11/24/93
Field Crew Mark Hart, James Miner
Weather Conditions Cloudy, winds 10 MPH, 40°F
Comments Drilled with bucket auger
Well Information Two wells installed; construction information in Appendix B

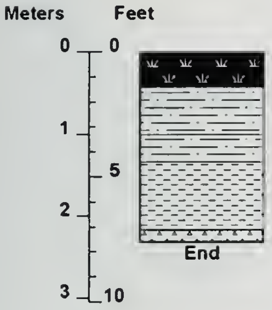


Depth		Unit Descriptions
0.00 –	0.46 m	**Muck;** black (N 2.5/); organic; rooty; plastic; silty clay texture; weakly calcareous; rare gastropod shell. Gradual contact to:
0.46 –	0.91 m	**Silty clay;** olive gray (5Y 5/2) with olive (5Y 5/4) mottles around roots; noncalcareous to weakly calcareous; increases in fine sand toward base.
0.91 –	1.75 m	**Sandy silt;** clayey; yellowish brown (10YR 5/6) with olive gray (5Y 5/2) mottles at root zones; noncalcareous; stiff; grades into silt at 1.52 m.
1.75 –	1.83 m	**Gravelly sand;** clast supported; poorly sorted; subangular; gravel is pebble-sized; grains consist of quartz, dolomite and reddish siltstone fragments.

APPENDIX A *continued*
Part 4 Geologic Logs of Borings

HICKORY GROVE #8

Location NW SW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date 01/10/94
Field Crew Christine Fucciolo, James Miner
Weather Conditions Snowing, 25°F
Comments Drilled with bucket auger
Well Information Two wells installed; construction information in Appendix B

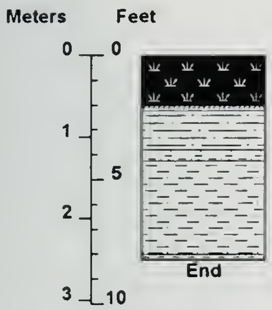


Depth		Unit Descriptions
0.00 –	0.43 m	**Peat;** black (N 2.5/); only modern roots, comprising about 5%, are visible; weakly calcareous; nonelastic; some fine sand; dry; slightly orange around roots especially between 0.36 m and 0.43 m where it is more clay-rich also.
0.43 –	1.02 m	**Clayey silt;** light olive brown (2.5Y 5/3); noncalcareous; grades to light olive brown (2.5Y 5/4) at 0.48 m, where it is also moist and is very brownish-orange around roots; grades back to light olive brown (2.5Y 5/3) with a small amount of orange color around roots by 0.61 m; still moist; grades to grayish brown (2.5Y 5/2) with a small amount of orange color around roots by 0.74 m; few roots (less than 1%) by this depth; at 0.74 m, free-standing water present in borehole, but sediments are not saturated. Sharp lower contact to:
1.02 –	1.35 m	**Clayey silt;** grayish brown (2.5Y 5/2); contains sand and about 10% gravel of shale and dolomite up to 5 mm in diameter; gravel is rounded to angular; yellowish brown (10YR 5/8) mottles; weakly calcareous; moist to saturated in sandier zones; possibly bedded. Sharp lower contact to:
1.35 –	2.16 m	**Silty clay;** very dark gray (2.5Y 3/1); structureless; dry; hard; very stiff; noncalcareous; some roots or wood with surrounding orange color comprises less than 10%; fibrous wood remnants in places; weakly calcareous in places; at 1.98 m, little if any wood present, less stiff also.
2.16 –	2.31 m	**Diamicton;** silty clay loam texture; gray (2.5Y 5/1); no visible structure; weakly calcareous; dry to moist; approximately 3% is pebbles and granules of dolomite and shale up to 5 mm in diameter.

APPENDIX A *continued*
Part 4 **Geologic Logs of Borings**

HICKORY GROVE #9

Location NW SW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date 01/10/94
Field Crew Christine Fucciolo, James Miner
Weather Conditions Snowing
Comments Drilled with bucket auger
Well Information Two wells installed; construction information in Appendix B



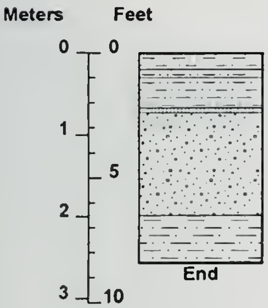
Depth	Unit Descriptions
0.00 – 0.61 m	**Peat;** black (N 2.5/ is closest, but deposit is slightly browner); very slightly elastic; fibrous; approximately 10% is visible roots; H_2S odor; noncalcareous; wet; saturated; does not stain hands; water exuded when squeezed is nearly colorless; at 0.30 m, becomes black (10YR 2/1), moderately elastic and very fibrous with about 40% consisting of visible organic fragments and some woody pieces; at 0.56, becomes very blackish, silty and nonelastic. Sharp lower contact to:
0.61 – 0.66 m	**Marl;** white (2.5Y 8/1); calcareous; $CaCO_3$ grains are pebble-sized; possibly in a silty clay matrix, but difficult to determine because of disturbance due to hand augering.
0.66 – 1.17 m	**Clayey silt;** dark gray (5Y 4/1); some fine sand present; approximately 5% is brownish wood fragments; noncalcareous; no visible structure; contains hard, but crushable lenses of $CaCO_3$; at 0.76 m, grades to gray (5Y 5/1). Sharp lower contact to:
1.17 – 1.30 m	**Silty sand;** dark gray (5YR 4/1); weakly calcareous; some clay; sand is medium to fine, rounded and moderately sorted; by 1.30 m, grades to grayish brown (2.5Y 5/2), fine to medium sand.
1.30 – 2.44 m	**Sandy silt;** grayish brown (2.5Y 5/2); sand is fine; approximately 3% is granules and pebbles up to 5 mm in diameter; weakly calcareous; no visible structure; by 1.75 m, grades into silty sand with pebbles; sand is fine, poorly sorted and rounded to subrounded; moist, but not saturated.
2.44 – 2.49 m	**Silty clay;** gray (5Y 5/1); moist, but not saturated; approximately 5% is fine sand; rare granules; rare dolomite pebble 5 mm in diameter; ends on rocky material.

APPENDIX A *continued*

Part 4 **Geologic Logs of Borings**

HICKORY GROVE #10

Location NW SW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date 01/11/94
Field Crew Christine Fucciolo, James Miner
Weather Conditions Sunny, 30°F
Comments Drilled with bucket auger
Well Information Two wells installed; construction information in Appendix B

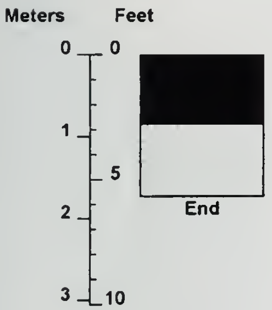


Depth	Unit Descriptions
0.00 – 0.20 m	**Sandy silt;** black (N 2.5/); sand is fine-grained; noncalcareous; modern roots prevalent; structureless; moist.
0.20 – 0.30 m	**Sandy silt;** very dark brown (10YR 2/2); slightly orange and slightly more clay-rich around roots; sand is fine-grained; structureless to fine crumb structure; moist. Gradual lower contact to:
0.30 – 0.66 m	**Sandy silt;** brown (10YR 4/3) matrix with yellowish brown (10YR 5/8) mottles; sand is fine; approximately 10% is granules and pebbles less than 5 mm in diameter; weakly calcareous; contains crushable concretions which are slightly calcareous; moist, but not saturated; grades into silty fine sand by 0.46 m; still weakly calcareous; matrix gradually becomes yellowish brown (10YR 5/8). Sharp lower contact to:
0.66 – 0.74 m	**Sandy clay;** gray (10YR 6/1); approximately 5% is pebbles of dolomite; slightly stiff; less moist and more clay-rich than above unit.
0.74 – 1.98 m	**Gravelly sand;** yellowish brown (10YR 5/8); less than 10% is silt; approximately 20% is granules and pebbles of dolomite up to 10 mm in diameter; pebbles are rounded; sand is poorly sorted and rounded to subangular; wet to saturated; loose; porous; soft; weakly calcareous; some pale brown (10YR 6/3) mottles; by 0.94 m, mottle color becomes matrix color.
1.98 – 2.57 m	**Clayey sand;** pale brown (10YR 6/3); sand is poorly sorted and rounded to subangular; moist, but not saturated; loose; porous; soft; weakly calcareous.

APPENDIX A *continued*
Part 4 **Geologic Logs of Borings**

HICKORY GROVE #11

Location NW SW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date 01/11/94
Field Crew Christine Fucciolo, James Miner
Weather Conditions Sunny, 30°F
Comments Drilled with bucket auger
Well Information Two wells installed; construction information in Appendix B

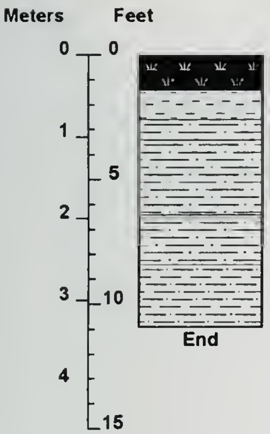


Depth	Unit Descriptions
0.00 – 0.86 m	**Muck;** black (N2.5/); organic; peaty; weakly calcareous; very slightly elastic; approximately 3% is visible modern roots; clayey silt texture; some fine sand; weak H_2S odor; moist, but water not exuded when squeezed; some degraded flat leaves, possibly representing *Typha* fragments; at 0.71 m, texture is more like silty clay and unit is more sticky and less stiff. Sharp lower contact to:
0.86 – 1.73 m	**Sand;** grayish; poorly sorted; fine to coarse; rounded to subangular; clasts up to 4 mm in diameter are white, gray, and red; clasts are mostly dolomite, but quartz and rock fragments also present; weakly calcareous; approximately 10% is roots which are absent by 1.50 m; at 1.50 m, clast percentage increases; sediment is liquified; coarsening; by 1.75 m, coarsens to gravelly sand; gravel is granule-sized, orange and gray, and consists mostly of dolomite; saturated.

APPENDIX A *continued*
Part 4 **Geologic Logs of Borings**

HICKORY GROVE #12

Location NW SW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date 01/12/94
Field Crew Christine Fucciolo, James Miner
Weather Conditions Cloudy, 20°
Comments Drilled with bucket auger
Well Information Two wells installed; construction information in Appendix B



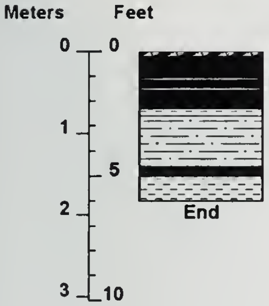
Depth	Unit Descriptions
0.00 – 0.43 m	**Peat;** black (N2.5/); very slightly elastic; calcareous; moist; approximately 5% is modern roots; some decayed matter visible. Sharp lower contact to:
0.43 – 0.48 m	**Silty sand;** olive gray (5Y 4/2); sand is fine, sorted, and subangular; contains many fine roots; moist. Sharp lower contact to:
0.48 – 1.04 m	**Clayey silt;** very dark gray (5Y 3/1); soft; noncalcareous; approximately 10% is fibrous plant remains, including woody fragments; contains white crushable concretions which are noncalcareous to weakly calcareous and 2.5 to 5.0 mm in diameter; moist, but not saturated; at 0.81 m, stiffer; less moist; sand and granule content increases to about 5 to 10%; some dolomite pebbles; woody fragments still present; noncalcareous to weakly calcareous.
1.04 – 1.96 m	**Clayey silt;** similar to 0.48–1.04 m, but gravel and sand absent; noncalcareous; woody fragments present. Sharp lower contact to:
1.96 – 1.98 m	**Sand;** dark gray (5Y 4/1); moderately sorted. Sharp lower contact to:
1.98 – 2.57 m	**Clayey silt;** dark gray (5Y 4/1); moist; sticky; soft; noncalcareous; rare dolomite pebble 5 mm in diameter present; at 1.91 m, less than 1% is granules; grades to silt by 2.57 m.
2.57 – 3.33 m	**Silt;** dark gray (5Y 4/1); moist, but not saturated; weakly calcareous; soft; no visible structure; thin sandy layer possibly present at 2.82 m, but silt below that.

APPENDIX A *continued*

Part 4 Geologic Logs of Borings

HICKORY GROVE #13

Location	SW NW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date	02/16/94
Field Crew	Christine Fucciolo, James Miner
Weather Conditions	Sunny, breezy, 32°F
Comments	Drilled with bucket auger
Well Information	Two wells installed; construction information in Appendix B



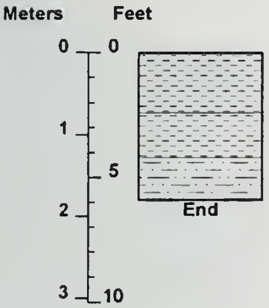
Depth		**Unit Descriptions**
0.00 –	0.06 m	**Organic material;** peaty mat of poorly decomposed modern organic material including stems and roots; poor recovery due to ice and frozen ground.
0.06 –	0.34 m	**Muck;** black (N2.5/); very slightly elastic; weakly calcareous; soft; decomposed roots; some silt-sized clastic material present.
0.34 –	0.46 m	**Muck;** black (N2.5/); slightly elastic; weakly calcareous; slightly stiffer than 0.06–0.34 m. Grades into:
0.46 –	0.70 m	**Muck;** black (N2.5/); peaty; slightly elastic; slightly calcareous; with pieces of brownish peat consisting of compressed, slightly decomposed roots and stems; slightly stiff. Sharp lower contact to:
0.70 –	0.79 m	**Silty clay;** black (N2.5/); organic; peaty; rooty; decomposed plant fragments; noncalcareous to weakly calcareous; no visible structure; soft. Sharp lower contact to:
0.79 –	1.40 m	**Clayey silt;** light brownish gray (5Y 6/2); contains light brownish plant remains possibly representing *Typha* leaf remnants; weakly calcareous; no visible structure.
1.40 –	1.52 m	**Peat;** dark brown (7.5YR 3/2); slightly decomposed, but organic fragments still discernable; noncalcareous; slight H_2S odor; slightly elastic. Grades into:
1.52 –	1.83 m	**Silty clay;** dark gray (10YR 4/1); peaty; approximately 25% is peat and plant fragments, including a wood remnant 5 mm in diameter; noncalcareous; at 1.55 m, weak lamination by color; between 1.55 and 1.68 m, hard, whitish, noncalcareous, crushable silty clay nodules present; woody remnants still present; at 1.83 m, becomes grayish and very stiff.

APPENDIX A *continued*

Part 4 **Geologic Logs of Borings**

HICKORY GROVE #14

Location SW NW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date 02/16/94
Field Crew Christine Fucciolo, James Miner
Weather Conditions Sunny, 40°F
Comments Drilled with bucket auger
Well Information Two wells installed; construction information in Appendix B

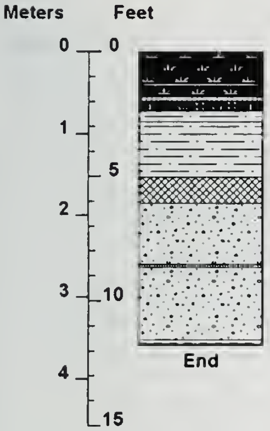


Depth		Unit Descriptions
0.00 –	0.73 m	**Silty clay;** black (N2.5/); organic; inelastic; weakly calcareous; rooty; no visible structure; at 0.64 m, very slight olive brown (2.5Y 4/4) mottling present around rootlets; also occasional whitish, crushable nodules 1.0 to 2.5 mm in diameter present. Grades into:
0.73 –	1.28 m	**Silty clay;** gray (10YR 5/1) matrix with yellowish brown (10YR 5/8) mottles possibly around former roots or pores; no visible structure; dry to moist; stiff. Gradual lower contact to:
1.28 –	1.80 m	**Clayey sand;** gray (10YR 5/1); matrix supported; approximately 50% is sand which is medium, moderately sorted, and subangular; less than 10% is silt; less than 3% is pebbles and granules up to 5 mm in diameter consisting of rock fragments and dolomite; soft; moist to saturated; by 1.52 m, grades to silty sand with gravel up to 20 mm in diameter; gravel is well rounded and consists of rock fragments, dolomite and blackish crystallines.

APPENDIX A *continued*
Part 4 **Geologic Logs of Borings**

HICKORY GROVE #1G

Location NW SW SE Sec. 5, T43N, R9E, Barrington Quadrangle, Illinois
Date 06/30/94
Field Crew Mark Hart, Christine Fucciolo, James Miner
Weather Conditions Sunny, 70° F
Comments Drilled with Giddings rig
Well Information One well installed, construction information in Appendix B

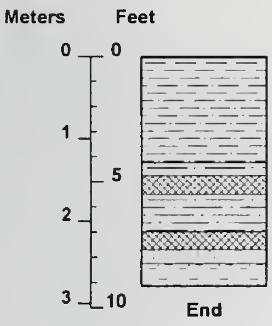


Depth	Unit Descriptions
0.00 – 0.41 m	**Peat;** black (N 2.5/); dry; calcareous; degraded; crumb structure; approximately 1% is shell fragments distributed throughout unit. Gradual lower contact to:
0.41 – 0.55 m	**Peat;** black (N 2.5/) but more grayish than above unit; slightly moist; calcareous; consolidated; intact gastropod shell at 0.48 m. Sharp lower contact to:
0.55 – 0.60 m	**Marl;** pale yellow (2.5Y 8/4); highly calcareous; granular and crumbly; porous; silty texture.
0.60 – 0.72 m	**Marly peat;** dark gray (10YR 4/1); marl similar to 0.55–0.60 m within peat; shell fragments; moist.
0.72 – 0.73 m	**Marl;** same as 0.55–0.60 m.
0.73 – 0.85 m	**Clayey silt;** gray (5Y 5/1); moist; structureless; contains small light orangish bodies. Gradual lower contact to:
0.85 – 1.53 m	**Clayey silt;** dark gray (2.5Y 4/1); bedded; beds contain approximately 5% of visible organic fragments (wood or roots); nonwoody beds contain 1–5% of well-rounded pebbles up to 10 mm in diameter of dolomite, quartzite, granitics and basaltics; slightly calcareous.
1.53 – 1.85 m	**No recovery.**
1.85 – 2.60 m	**Gravelly sand;** dark gray (2.5Y 4/1); contains some silt; poorly sorted; sand is coarse, rounded to well rounded, and crudely bedded 5–10 cm thick by grain size; pebbles are up to 10 mm in diameter.
2.60 – 2.64 m	**Sand**; dark gray (5Y 4/1); very fine; well sorted; very slightly laminated.
2.64 – 3.51 m	**Gravelly sand;** similar to 1.85–2.60 m, but with gravel up to 30 mm in diameter; saturated.
3.51 – 3.58 m	**Silty clay;** grayish brown (10YR 5/2); highly calcareous; laminated; dry.

HICKORY GROVE #1S

Location NE SW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date 06/28/94
Field Crew Mark Hart, James Miner
Weather Conditions Overcast, rainy, 80 °F
Comments Drilled with soil probe. Located 5 m north of the center of the east–west ditch, adjacent to stage gauge B

Well Information No wells installed

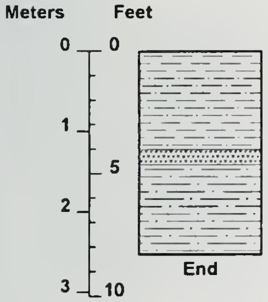


Depth		Unit Descriptions
0.00 –	1.29 m	**Peaty silt;** black (N 2.5/); dry; calcareous; light brownish gray (10YR 6/2) silty layer present between 0.10–0.20 m with granular texture and calcareous nodules up to 30 mm in diameter; peaty structure at 0.20–0.50 m; contains shell fragments; moist near base.
1.29 –	1.45 m	**Clayey silt;** gray (5Y 5/1); weakly calcareous; woody fragments present; structureless; small, dark yellowish brown (10YR 4/6) silt nodules 1–2 mm in diameter present; dark crack infillings present; slightly brittle.
1.45 –	1.68 m	**No recovery.**
1.68 –	2.13 m	**Clayey silt;** dark gray (5Y 4/1); bedded with sand and dolomite pebbles; pebbles are well rounded, less than 10 mm in diameter, and comprise approximately 1–3%; beds are 30–50 mm thick; wood and roots throughout.
2.13 –	2.35 m	**No recovery.**
2.35 –	2.52 m	**Sand;** gray (5Y 5/1); medium to coarse; saturated; loose. Gradual lower contact to:
2.52 –	2.80 m	**Silty sand;** gray (5Y 5/1); sand is very fine; structureless; moist.

APPENDIX A *continued*
Part 4 Geologic Logs of Borings

HICKORY GROVE #2S

Location	NW SW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date	06/28/94
Field Crew	Mark Hart, James Miner
Weather Conditions	Overcast, rainy, 80 °F
Comments	Drilled with soil probe. Located 5 m north of the center of the east–west ditch and 50 m west of boring #1S
Well Information	No wells installed



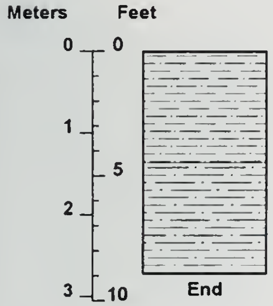
Depth	Unit Descriptions
0.00 – 1.22 m	**Peaty silt;** black (N 2.5/); rooty; degraded peat structure in top 0.30 m with peaty structure below; dry; brownish white, granular, calcareous layers 5 mm thick at 0.15, 0.25, and 0.29 m; wood fragments and leaves at 0.55–0.60 m; shell fragments present below 0.70 m; moist in last 0.20 m; rare whitish nodules.
1.22 – 1.41 m	**Marl;** very pale brown (10YR 7/3); granular texture; highly calcareous.
1.41 – 2.53 m	**Clayey silt;** dark gray (10YR 4/1); moist; approximately 5% is wood fragments; contains lenses up to 50 mm thick of coarse sand and dolomite pebbles at 1.62 m and 1.73 m.

APPENDIX A *continued*

Part 4 **Geologic Logs of Borings**

HICKORY GROVE #3S

Location	NW SW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date	06/28/94
Field Crew	Mark Hart, James Miner
Weather Conditions	Overcast, rainy, 80 °F
Comments	Drilled with soil probe. Located 5 m north of center of the east–west ditch and 50 m west of boring #2S
Well Information	No wells installed

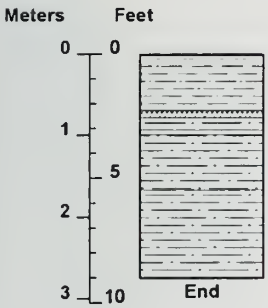


Depth	**Unit Descriptions**
0.00 – 1.35 m	**Peaty silt;** black (N 2.5/); rooty; degraded peat structure in upper 0.30 m with peaty structure below; whitish marl in peaty matrix at 0.24–0.30 m; shell fragments in matrix below 0.30 m; shelly layer at 0.75 m.
1.35 – 2.70 m	**Clayey silt;** dark gray (10YR 4/1); contains woody fragments; some sand dispersed in matrix below 2.30 m; contains some brownish gray beds with wood fragments.

APPENDIX A *continued*
Part 4 **Geologic Logs of Borings**

HICKORY GROVE #4S

Location	NW SW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date	06/28/94
Field Crew	Mark Hart, James Miner
Weather Conditions	Overcast, rainy, 80 °F
Comments	Drilled with soil probe. Located 5 m north of the center of the east–west ditch and 50 m west of boring #3S
Well Information	No wells installed

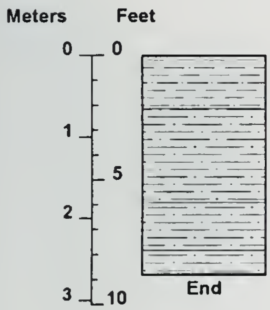


Depth		Unit Descriptions
0.00 –	0.70 m	**Peaty silt;** black (N 2.5/); rooty; dry; no peaty structure; grayish white marl layer 5 mm in thickness at 0.26 m. Gradual lower contact to:
0.70 –	0.79 m	**Peaty marl;** grayish white mixed with black peaty silt.
0.79 –	0.93 m	**Clayey silt;** gray (5Y 5/1); structureless; contains oxidized root channels that are dark yellowish brown (10YR 4/6).
0.93 –	1.00 m	**Clayey silt;** dark gray (N 4/); root or mixed zone.
1.00 –	1.67 m	**Clayey silt;** gray (5Y 5/1); contains wood fragments and shells; mottled grayish brown (2.5Y 5/2).
1.67 –	2.74 m	**Clayey silt;** gray (5Y 5/1); bedded with 5-mm thick layers of coarse sand and pebbles; wood fragments present, but less numerous than in 1.00–1.67 m. .

APPENDIX A *continued*
Part 4 **Geologic Logs of Borings**

HICKORY GROVE #5S

Location	NW SW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date	06/28/94
Field Crew	Mark Hart, James Miner
Weather Conditions	Overcast, rainy, 80 °F
Comments	Drilled with soil probe. Located 5 m north of the center of the east–west ditch and 50 m west of boring #4S
Well Information	No wells installed

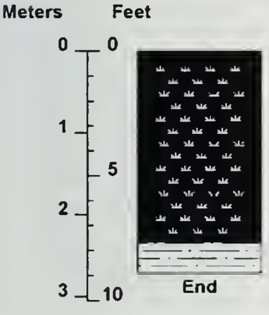


Depth		Unit Descriptions
0.00 –	0.65 m	**Peaty silt;** black (N 2.5/); calcareous; rooty; peaty structure below 0.30 m; dispersed marl from 0.10–0.17 m; slight color change at 0.30 m; hard peat at base.
0.65 –	1.80 m	**Clayey silt;** weakly calcareous; wood fragments present; contains burnt orange, hard, noncalcareous, horizontal layers and vertical fillings (possibly representing bog iron) especially at 0.87–0.89 m; 10-mm thick marl layer at 0.80 m; grades to olive gray (5Y 5/2) by 1.10 m; more silty clay and less organic material toward base.
1.80 –	2.38 m	**Clayey silt;** very dark gray (10YR 3/1); contains wood and shell fragments; soft; saturated.
2.38 –	2.68 m	**Clayey silt;** dark gray (2.5Y 4/1); very dense; moist to dry; rare, small, noncalcareous, grayish white silt nodules.

APPENDIX A *continued*
Part 4 **Geologic Logs of Borings**

HICKORY GROVE #6S

Location	NW SW SE Sec. 5, T43N, R9E, Barrington 7.5-minute Quadrangle, Illinois
Date	06/28/94
Field Crew	Mark Hart, James Miner
Weather Conditions	Overcast, rainy, 80 °F
Comments	Drilled with soil probe. Located 5 m north of the center of the east–west ditch and 50 m west of boring #5S
Well Information	No wells installed



Depth		Unit Descriptions
0.00 –	2.33 m	**Peat;** very dark brown (10YR 2/2); dry; very fibrous; rooty; noncalcareous; dispersed whitish marl occurs between 0.30–0.40 m; burnt orange platy bodies (possibly representing bog iron) occur between 0.61–0.70 m; below 0.70 m, peat becomes moist, elastic; below 1.60 m, peat becomes sapric and soft.
2.33 –	2.70 m	**Clayey silt;** grayish brown (2.5Y 5/2); contains dispersed coarse sand and small dolomite granules.

APPENDIX B Well Construction Information

Table B1 Construction information for monitoring wells.

Construction Information	Well 1	Well 2U	Well 2L	Well 3	Well 4U	Well 4L	Well 5U	Well 5L	Well 6U	Well 6L
Relative elevation of well top (m)	40.17	35.34	35.01	32.78	32.15	31.83	30.61	31.01	31.19	30.81
Relative land surface elevation (m)	39.18	34.24	34.24	31.87	31.11	31.12	30.25	30.22	30.03	30.02
Total length of well (m)	2.81	1.86	3.81	1.88	2.08	2.92	1.27	2.34	1.86	2.55
Measuring point height**	0.99	1.10	0.77	0.91	1.04	0.71	0.36	0.79	1.16	0.79
Screen length (m)	0.76	0.30	0.76	0.30	0.30	0.76	0.30	0.76	0.34	0.76
Depth of borehole***	1.82	0.76	3.29	2.44	1.04	2.13	0.91	3.51	0.70	1.75
Concrete seal top***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Concrete seal bottom***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bentonite seal top***	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bentonite seal bottom***	1.13	*	*	0.46	*	*	0.30	0.58	*	*
Sand pack top***	1.13	*	*	0.46	*	*	0.30	0.58	*	*
Sand pack bottom***	1.82	0.76	3.04	0.97	1.04	2.07	0.91	1.55	0.70	1.75
Depth to top of screen***	1.06	0.46	2.28	0.67	0.74	1.45	0.61	0.79	0.36	1.00
Depth to bottom of screen***	1.82	0.76	3.04	0.97	1.04	2.21	0.91	1.55	0.70	1.76
Screened unit(s)	C	A	C,D	A,B	A	C	A	C,D	B	C

Table B1 *continued*

Construction Information	Well 7U	Well 7L	Well 8U	Well 8L	Well 9U	Well 9L	Well 10U	Well 10L	Well 11U	Well 11L
Relative elevation	31.63	30.84	32.83	32.33	36.21	36.30	39.00	38.74	38.97	38.76
Relative land surface elevation	30.57	30.56	31.53	31.52	34.99	35.16	37.50	37.50	37.80	37.82
Total length of well (m)	1.46	2.19	2.06	2.33	1.93	3.81	2.26	3.81	1.88	2.95
Measuring point height**	1.06	0.28	1.30	0.81	1.22	1.14	1.50	1.24	1.17	0.94
Screen length (m)	0.21	0.76	0.30	0.76	0.38	0.76	0.30	0.76	0.30	0.76
Depth of borehole***	0.40	1.83	0.76	2.31	0.71	2.49	0.76	2.57	0.71	1.73
Concrete seal top***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Concrete seal bottom***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bentonite seal top***	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bentonite seal bottom***	*	*	*	0.76	*	*	*	1.76	*	0.45
Sand pack top***	*	*	*	0.76	*	*	*	1.76	*	0.45
Sand pack bottom***	0.40	1.82	0.76	1.52	0.71	2.49	0.76	2.57	0.71	2.01
Depth to top of screen***	0.19	1.15	0.46	0.76	0.33	1.91	0.46	1.81	0.41	1.25
Depth to bottom of screen***	0.40	1.91	0.76	1.52	0.71	2.67	0.76	2.57	0.71	2.01
Screened unit(s)	A	C,D	B	B,C,D	A,B	C	E(A)	C	A	C

NA Not applicable
* Data not available
** Reported in m above land surface
*** Reported in m below land surface

APPENDIX B *continued*

Table B1 *continued*

Construction Information	Well 12U	Well 12L	Well 13U	Well 13L	Well 14U	Well 14L	Well 2R	Well 1G
Relative elevation of well top (m)	35.96	35.28	33.76	34.13	32.74	32.13	47.80	32.06
Relative land surface elevation (m)	34.61	34.54	32.54	32.61	31.43	31.39	46.86	31.09
Total length of well (m)	1.88	3.81	1.96	3.53	1.95	2.80	17.27	3.86
Measuring point height**	1.35	0.74	1.22	1.52	1.31	0.74	0.94	0.97
Screen length (m)	0.30	0.76	0.30	0.76	0.43	0.76	0.76	0.67
Depth of borehole***	0.53	3.33	0.74	1.83	0.64	1.80	16.31	3.58
Concrete seal top***	NA	NA	NA	NA	NA	NA	NA	0.00
Concrete seal bottom***	NA	NA	NA	NA	NA	NA	NA	0.30
Bentonite seal top***	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00
Bentonite seal bottom***	0.20	1.73	0.29	1.16	0.15	1.06	14.96	2.10
Sand pack top***	0.20	1.73	0.29	1.16	0.15	1.06	14.96	2.10
Sand pack bottom***	0.53	3.07	0.74	1.82	0.64	1.79	16.33	2.89
Depth to top of screen***	0.23	2.31	0.44	1.25	0.21	1.30	15.57	2.22
Depth to bottom of screen***	0.53	3.07	0.74	2.01	0.64	2.06	16.33	2.84
Screened unit(s)	A,B	B,C	A,B	B,C	A	B,C	M	C

NA Not applicable
* Data not available
** Reported in m above land surface
*** Reported in m below land surface

APPENDIX C Water-Level Elevations and Depths to Water Below Land Surface

Table C1 Relative water-level elevations (in m).

	12/16/93	02/02/94	03/15/94	04/18/94	05/13/94	06/29/94	07/26/94	09/01/94	10/05/94	11/02/94	11/29/94
Well 1	37.95	dry	37.87	37.83	37.79	removed	removed	removed	removed	removed	removed
Well 2U	33.66	33.63	33.66	33.64	33.63	33.66	dry	33.66	33.63	33.63	33.65
Well 2L	33.83	33.78	33.82	33.77	37.79	33.66	33.52	33.66	33.63	33.75	33.82
Well 3	31.42	dry	31.50	31.38	34.00	31.28	31.28	31.87	31.32	31.87	37.62
Well 4U	dry	dry	30.21	dry	dry	dry	dry	dry	dry	dry	30.21
Well 4L	30.10	dry	30.24	30.10	30.00	29.78	29.68	29.57	29.52	29.78	30.23
Well 5U	30.02	29.91	30.12	29.90	29.79	dry	dry	dry	dry	dry	30.45
Well 5L	29.92	29.87	30.10	29.56	29.86	29.78	29.68	dry	dry	29.78	30.45
Well 6U	29.91	29.83	frozen	29.58	29.41	29.70	dry	dry	dry	29.60	29.61
Well 6L	29.17	29.02	29.32	29.50	29.31	29.78	29.68	dry	dry	29.68	29.62
Well 7U	30.51	30.58	frozen	30.44	30.20	*	dry	dry	dry	dry	30.45
Well 7L	30.57	30.66	frozen	30.49	30.20	*	29.37	29.22	28.86	29.22	30.52
Well 8U	**	31.38	31.44	31.27	dry	dry	dry	dry	dry	dry	31.34
Well 8L	**	31.34	31.41	31.25	30.20	30.16	dry	dry	dry	30.16	31.26
Well 9U	**	34.80	34.87	35.20	35.16	35.04	30.16	35.13	35.04	31.87	30.45
Well 9L	**	frozen	removed	removed	removed	removed	removed	removed	removed	removed	removed
Well 10U	**	36.90	37.15	36.97	removed	removed	removed	removed	removed	removed	removed
Well 10L	**	frozen	frozen	37.46	removed	removed	removed	removed	removed	removed	removed
Well 11U	**	37.58	37.64	37.57	32.51	37.44	31.87	37.44	37.41	37.52	37.62
Well 11L	**	37.62	frozen	37.63	37.60	37.45	37.37	37.44	37.42	37.44	37.62
Well 12U	**	frozen	34.20	dry	dry	dry	dry	dry	dry	dry	dry
Well 12L	**	*	34.29	34.24	34.00	31.07	33.66	34.00	33.63	31.07	34.14
Well 13U	**	**	32.48	32.49	32.48	32.22	dry	34.00	32.00	dry	30.45
Well 13L	**	**	32.51	32.53	32.51	32.26	31.87	33.63	32.03	30.16	30.45
Well 14U	**	**	31.36	31.30	31.11	30.59	dry	dry	dry	31.07	31.34
Well 14L	**	**	31.18	31.10	30.23	30.59	30.16	30.23	29.93	30.92	31.16
Well 2R	**	**	39.66	39.56	34.00	39.21	30.16	33.63	37.79	38.77	38.79
Well 1G	**	**	**	**	**	**	29.78	29.57	29.57	29.81	30.34
Gauge A	**	**	29.50	29.42	29.39	29.39	*	29.36	29.37	29.78	29.43
Gauge B	**	**	30.28	30.28	30.87	30.87	dry	30.27	30.28	30.31	30.31
Gauge C	**	**	31.90	31.90	31.87	31.90	31.87	34.60	31.90	31.87	31.34

* no measurement
** not yet installed

APPENDIX C *continued*

Table C1 *continued*

	01/12/95	02/08/95	03/14/95	03/21/95	04/05/95	05/02/95	06/13/95	07/11/95	08/15/95	09/12/95	10/13/95	11/15/95	11/16/95	12/05/95
Well 1	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed
Well 2U	33.62	33.59	33.62	33.36	33.61	33.63	33.58	33.56	33.59	33.55	33.58	33.61	*	33.61
Well 2L	33.73	33.71	33.76	33.86	33.83	33.87	33.78	33.74	33.76	33.70	33.61	33.50	*	33.88
Well 3	31.37	31.34	31.58	31.49	31.40	31.44	31.30	31.30	31.38	31.34	31.39	37.49	*	31.86
Well 4U	dry	dry	30.27	30.24	dry	30.22	dry	dry	dry	dry	dry	30.19	*	dry
Well 4L	30.05	30.08	30.30	30.23	30.12	30.22	30.01	29.84	29.65	29.49	28.69	30.19	*	30.12
Well 5U	29.83	29.80	30.08	30.05	30.00	30.08	29.68	29.37	dry	dry	29.42	30.61	*	29.98
Well 5L	29.81	29.79	30.07	30.15	29.99	30.07	29.66	29.37	29.10	28.99	29.42	30.58	*	29.98
Well 6U	dry	dry	29.66	29.60	29.47	29.64	dry	dry	dry	dry	dry	28.69	*	29.42
Well 6L	29.20	29.25	29.67	29.61	29.45	29.63	29.18	28.81	dry	dry	28.69	29.57	*	29.42
Well 7U	30.24	frozen	30.56	30.56	30.51	30.54	dry	dry	dry	dry	dry	30.58	*	30.53
Well 7L	30.30	frozen	30.54	30.56	30.52	30.54	29.98	29.67	29.32	29.23	28.69	30.61	*	30.54
Well 8U	dry	31.07	31.41	31.28	31.07	31.17	dry	dry	dry	dry	dry	*	31.06	31.82
Well 8L	30.99	31.02	31.34	31.27	31.04	31.15	30.63	dry	dry	dry	dry	*	31.04	31.06
Well 9U	34.83	34.87	34.83	34.97	34.96	34.96	34.96	34.96	34.97	35.03	35.03	*	35.03	35.03
Well 9L	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed
Well 10U	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed
Well 10L	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed
Well 11U	37.52	37.46	37.63	37.65	37.59	37.64	37.55	37.43	37.66	37.43	37.49	38.61	*	31.86
Well 11L	37.48	frozen	37.58	37.68	37.62	37.69	37.58	37.46	37.53	37.44	37.49	37.65	*	37.64
Well 12U	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	*	dry
Well 12L	34.07	34.09	34.15	34.16	34.13	34.17	34.07	34.03	34.01	33.96	33.61	34.11	*	30.12
Well 13U	32.22	32.27	32.45	32.51	32.41	32.49	32.12	dry	32.09	dry	32.17	32.43	*	32.47
Well 13L	32.21	32.28	32.49	32.51	32.40	32.50	32.13	32.02	32.04	31.69	30.19	32.44	*	32.46
Well 14U	30.95	31.11	31.34	31.34	31.24	31.30	dry	dry	dry	dry	dry	removed	removed	removed
Well 14L	30.74	30.94	31.14	31.34	31.24	31.30	30.63	30.57	30.29	30.10	30.58	31.39	*	31.32
Well 2R	39.72	38.75	38.81	*	38.80	39.04	39.09	38.95	38.81	38.67	38.61	38.58	*	33.61
Well 1G	30.16	30.18	30.39	30.30	30.21	30.30	30.10	29.91	29.73	29.54	29.57	30.24	*	30.24
Gauge A	frozen	frozen	29.41	29.39	29.37	29.39	29.35	29.34	29.35	29.34	29.37	29.40	*	29.38
Gauge B	30.28	frozen	30.22	30.22	30.22	30.23	30.23	30.23	30.23	30.22	30.23	30.24	*	30.24
Gauge C	frozen	frozen	31.86	*	31.84	31.85	31.85	31.84	31.84	31.84	31.39	*	31.86	31.86

* no measurement
** not yet installed

APPENDIX C *continued*

Table C2 Depth to water in monitoring wells referenced to land surface (in m).

	12/16/93	02/02/94	03/15/94	04/18/94	05/13/94	06/29/94	07/26/94	09/01/94	10/05/94	11/02/94	11/29/94
Well 1	1.23	dry	1.31	1.35	1.39	removed	removed	removed	removed	removed	removed
Well 2U	0.58	0.61	0.58	0.60	0.61	0.66	dry	0.65	0.65	0.61	0.59
Well 2L	0.41	0.46	0.42	0.47	0.51	0.58	0.72	0.58	0.58	0.49	0.42
Well 3	0.45	dry	0.37	0.49	0.54	0.59	0.65	0.56	0.55	0.27	0.20
Well 4U	dry	dry	0.90	dry	dry	dry	dry	dry	dry	dry	0.90
Well 4L	1.02	dry	0.88	1.02	1.07	1.26	1.44	1.61	1.60	1.34	0.89
Well 5U	0.23	0.34	0.13	0.35	0.46	dry	dry	dry	dry	dry	0.17
Well 5L	0.30	0.35	0.12	0.66	0.46	0.97	1.24	dry	dry	1.17	0.17
Well 6U	0.12	0.20	frozen	0.45	0.62	0.63	dry	dry	dry	0.53	0.42
Well 6L	0.85	1.00	0.70	0.52	0.71	1.17	1.35	dry	dry	1.35	0.40
Well 7U	0.06	-0.01	frozen	0.13	0.35	*	dry	dry	dry	dry	0.12
Well 7L	-0.01	-0.10	frozen	0.07	0.36	*	1.19	1.34	1.70	1.34	0.04
Well 8U	**	0.15	0.09	0.26	dry	dry	dry	dry	dry	dry	0.23
Well 8L	**	0.18	0.11	0.27	0.66	1.06	dry	dry	dry	0.57	0.26
Well 9U	**	0.19	0.12	-0.21	-0.17	-0.05	-0.16	-0.14	-0.05	0.12	0.14
Well 9L	**	frozen	removed	removed	removed	removed	removed	removed	removed	removed	removed
Well 10U	**	0.60	0.35	0.53	removed	removed	removed	removed	removed	removed	removed
Well 10L	**	frozen	frozen	0.04	removed	removed	removed	removed	removed	removed	removed
Well 11U	**	0.22	0.16	0.23	0.23	0.36	0.46	0.36	0.39	0.28	0.18
Well 11L	**	0.20	frozen	0.19	0.22	0.37	0.45	0.38	0.40	0.34	0.22
Well 12U	**	frozen	0.41	dry	dry	dry	dry	dry	dry	dry	dry
Well 12L	**	*	0.25	0.30	0.36	0.46	0.60	0.54	0.55	0.46	0.40
Well 13U	**	**	0.06	0.05	0.06	0.32	dry	0.55	0.54	dry	0.09
Well 13L	**	**	0.10	0.08	0.10	0.35	0.74	0.58	0.58	0.15	0.12
Well 14U	**	**	0.07	0.13	0.32	0.49	dry	dry	dry	0.36	0.09
Well 14L	**	**	0.21	0.29	0.56	0.80	1.23	1.16	1.46	0.47	0.23
Well 2R	**	**	7.20	7.30	7.46	7.65	7.80	7.93	8.07	8.09	8.07
Well 1G	**	**	**	**	**	**	1.30	1.52	1.52	1.28	0.75

* no measurement
** not yet installed
\- indicates water above land surface

APPENDIX C *continued*

Table C2 *continued*

	01/12/95	02/08/95	03/14/95	03/21/95	04/05/95	05/02/95	06/13/95	07/11/95	08/15/95	09/12/95	10/13/95	11/15/95	11/16/95	12/05/95
Well 1	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed
Well 2U	0.62	0.65	0.62	0.88	0.63	0.61	0.66	0.68	0.65	0.69	0.56	0.63	*	0.6[illegible]
Well 2L	0.51	0.53	0.48	0.38	0.41	0.37	0.46	0.50	0.48	0.54	0.57	0.34	*	0.36
Well 3	0.50	0.53	0.29	0.39	0.47	0.43	0.57	0.57	0.49	0.53	0.48	0.41	*	0.11
Well 4U	dry	dry	0.84	0.87	dry	0.89	dry	dry	dry	dry	dry	0.92	*	dry
Well 4L	1.07	1.04	0.82	0.89	1.00	0.90	1.11	1.28	1.47	1.63	1.48	0.93	*	1.00
Well 5U	0.42	0.45	0.17	0.20	0.25	0.17	0.57	0.88	dry	dry	0.85	0.18	*	0.27
Well 5L	0.41	0.43	0.15	0.07	0.23	0.15	0.56	0.85	1.12	1.23	0.80	0.16	*	0.27
Well 6U	dry	dry	0.37	0.43	0.56	0.39	dry	dry	dry	dry	dry	0.45	*	0.67
Well 6L	0.82	0.77	0.35	0.41	0.57	0.39	0.84	1.21	dry	dry	1.33	0.45	*	0.60
Well 7U	0.33	frozen	0.01	0.01	0.06	0.03	dry	dry	dry	dry	dry	0.04	*	0.27
Well 7L	0.26	frozen	0.02	0.00	0.04	0.02	0.58	0.89	1.24	1.33	1.53	0.02	*	0.02
Well 8U	dry	0.46	0.12	0.25	0.46	0.36	dry	dry	dry	dry	dry	*	0.47	0.51
Well 8L	0.53	0.50	0.18	0.25	0.48	0.37	0.89	dry	dry	dry	dry	*	0.48	0.[illegible]2
Well 9U	0.16	0.12	0.16	0.02	0.03	0.03	0.03	0.03	0.02	-0.04	-0.04	*	-0.04	-0.04
Well 9L	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed
Well 10U	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed
Well 10L	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed	removed
Well 11U	0.28	0.34	0.17	0.15	0.21	0.16	0.25	0.37	0.14	0.37	0.32	0.18	*	0.11
Well 11L	0.34	frozen	0.24	0.14	0.20	0.13	0.24	0.36	0.29	0.38	0.33	0.17	*	0.19
Well 12U	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	*	dry
Well 12L	0.47	0.45	0.39	0.38	0.41	0.37	0.47	0.51	0.53	0.58	0.52	0.43	*	0.62
Well 13U	0.32	0.27	0.09	0.03	0.13	0.05	0.42	dry	0.45	dry	0.37	0.11	*	0.07
Well 13L	0.40	0.33	0.12	0.10	0.21	0.11	0.48	0.59	0.57	0.92	0.45	0.17	*	0.19
Well 14U	0.48	0.32	0.09	0.09	0.19	0.13	dry	dry	dry	dry	dry	removed	removed	removed
Well 14L	0.65	0.45	0.25	0.05	0.15	0.09	0.76	0.82	1.10	1.29	0.81	0.09	*	0.27
Well 2R	7.14	8.11	8.05	*	8.06	7.82	7.77	7.91	8.05	8.19	8.25	8.18	*	8.19
Well 1G	0.93	0.91	0.70	0.79	0.88	0.79	0.99	1.18	1.36	1.55	1.47	0.82	*	0.69

* no measurement
** not yet installed
\- indicates water above land surface

APPENDIX D Results of Water-Chemistry Analyses

Table D1 Abbreviatons used in Appendix D. Results of water-chemistry analyses are reported for the dissolved phase of the chemical species. All values reported in mg/L (ppm) except temperature, specific conductivity, conductivity, pH, and Eh. General use water quality standards[1] are included for comparison. Values in bold typeface exceed the general use standard. Sampling sites are shown on figure 4.

WATER QUALITY ANALYSES

Tot. Dis. C	Total Dissolved Carbon
Inorg. Dis. C	Inorganic Dissolved Carbon
Org. Dis. C	Dissolved Organic Carbon
Tot. N	Total Nitrogen
TKN	Total Kjeldahl Nitrogen
NH3-N	Ammonia Nitrogen
NO2-N	Nitrite Nitrogen
NO3-N	Nitrate Nitrogen
Sol. PO4-P	Ortho Phosphorus
Tot. P	Total Phosphorus
SO4	Sulfate Sulfur
F	Fluoride
Cl	Chloride
Br	Bromide
Hard.	Hardness by Calculation
Tot. Alkal.	Total Alkalinity
Sp. Cond.	Specific Conductivity (in µS)

FIELD-MEASURED PARAMETERS

Cond.	Conductivity (in µS)
pH	pH
Redox	Oxidation Reduction Potential (Eh) (in eV)
Temp.	Temperature (in °C)

ICP ANALYSES

Al	Aluminum
As	Arsenic
B	Boron
Ba	Barium
Be	Beryllium
Ca	Calcium
Cd	Cadmium
Co	Cobalt
Cr	Chromium
Cu	Copper
Fe	Iron
K	Potassium
La	Lanthanum
Li	Lithium
Mg	Magnesium
Mn	Manganese
Mo	Molybdenum
Na	Sodium
Ni	Nickel
Pb	Lead
Sb	Antimony
Sc	Scandium
Se	Selenium
Si	Silicon
Sr	Strontium
Ti	Titanium
Tl	Thallium
V	Vanadium
Zn	Zinc
Zr	Zirconium

[1]Illinois Environmental Protection Agency, amendments through December 30, 1994, Title 35: Environmental Protection, Subtitle C: Water Pollution. Chapter I: Pollution Control Board (Illinois Administrative Code 302.201–.212) pp. 9–12.

APPENDIX D *continued*

Table D2 Results of water-chemistry analyses at the Hickory Grove site.

		Water Quality Analyses																
Map ID (figure 4)	Sampling Date	Tot. Dis. C	Inorg. Dis. C	Org. Dis. C	Tot. N	TKN	NH3-N	NO2-N	NO3-N	Sol. PO4-P	Tot. P	SO4	F	Cl	Br	Hard.	Tot. Alkal.	Sp. Cond.
C 1	05/13/94	213.0	73.6	139.4	1.35	0.21	0.08	<0.01	1.14	<0.01	0.01	61.5	<0.01	21.3	<0.01	481	336	750
C 1	11/09/94	90.0	76.8	13.2	1.65	0.54	0.01	<0.01	1.11	<0.01	0.07	94.1	<0.01	30.1	<0.01	431	288	673
C 1	04/18/95	81.5	59.5	22.0	1.30	0.67	0.05	<0.01	0.63	<0.01	0.08	52.6	<0.01	52.4	<0.01	333	237	632
C 1	07/21/95	94.8	84.6	10.2	1.33	0.10	0.02	<0.01	1.23	<0.01	0.05	62.4	<0.01	22.5	<0.01	440	342	776
C 1	10/05/95	116.2	78.2	38.0	1.51	0.17	<0.01	<0.01	1.34	<0.01	0.05	57.1	<0.01	26.9	<0.01	454	364	800
C 2	05/13/94	216.1	75.7	140.4	1.46	0.19	0.01	<0.01	1.27	<0.01	0.06	61.6	<0.01	21.4	<0.01	472	349	655
C 2	11/09/94	98.3	83.0	15.3	1.88	0.10	<0.01	<0.01	1.78	<0.01	0.06	95.8	<0.01	27.5	<0.01	467	324	718
C 2	02/17/95	113.2	85.7	27.5	1.60	<0.01	0.01	<0.01	1.62	<0.01	0.02	70.8	<0.01	25.8	0.02	465	343	798
C 2	04/18/95	88.0	73.4	14.6	1.35	0.27	0.02	<0.01	1.08	<0.01	0.05	64.0	<0.01	19.2	<0.01	407	305	683
C 2	07/21/95	95.0	84.0	11.0	1.51	0.22	0.01	<0.01	1.29	<0.01	0.03	62.6	<0.01	23.0	0.06	438	340	719
C 2	10/05/95	107.0	75.5	31.5	1.57	<0.01	<0.01	<0.01	1.70	<0.01	0.08	65.9	<0.01	29.0	0.04	454	338	769
C 3	05/13/94	218.7	77.7	141.0	1.97	0.22	0.01	<0.01	1.75	<0.01	0.02	58.7	<0.01	21.3	<0.01	478	348	676
C 3	11/09/94	104.7	95.6	9.1	1.92	<0.01	<0.01	<0.01	2.42	<0.01	0.04	60.9	<0.01	25.2	0.03	454	355	718
C 3	02/17/95	107.8	87.0	20.8	2.19	<0.01	<0.01	<0.01	2.20	<0.01	<0.01	67.0	<0.01	27.2	<0.01	473	356	776
C 3	04/18/95	90.0	79.3	10.7	1.68	<0.01	0.05	<0.01	1.68	<0.01	0.02	62.0	<0.01	23.6	<0.01	436	323	695
C 3	07/21/95	98.7	87.9	10.8	1.75	<0.01	<0.01	<0.01	1.84	<0.01	0.06	59.9	<0.01	23.4	0.06	426	350	731
C 3	10/05/95	109.1	77.6	31.5	1.97	0.99	<0.01	<0.01	0.98	<0.01	0.06	20.1	0.29	12.6	<0.01	471	344	800
C 4	05/13/94	207.0	74.2	132.8	0.29	0.21	<0.01	<0.01	0.08	<0.01	0.05	64.7	<0.01	12.9	<0.01	445	340	624
C 4	11/09/94	97.2	83.5	13.7	1.58	0.29	0.03	<0.01	1.29	<0.01	0.07	115.0	<0.01	17.0	<0.01	478	321	673
C 4	04/18/95	85.3	71.7	13.6	1.03	0.53	0.01	<0.01	0.50	<0.01	0.06	64.8	<0.01	9.1	<0.01	394	295	597
C 4	07/21/95	96.8	86.1	10.7	0.66	0.51	<0.01	<0.01	0.15	<0.01	0.10	59.7	<0.01	10.8	<0.01	403	344	674
C 4	10/05/95	110.2	77.6	32.6	1.44	1.32	<0.01	<0.01	0.12	<0.01	0.31	63.5	<0.01	11.5	<0.01	419	348	727
C 5	05/13/94	239.8	95.5	144.3	0.24	0.06	<0.01	<0.01	0.18	<0.01	0.03	74.5	<0.01	24.4	<0.01	491	360	793
C 5	11/09/94	99.6	92.2	7.4	0.46	0.28	0.02	<0.01	0.18	<0.01	<0.01	73.9	<0.01	23.0	0.03	435	336	718
C 5	02/17/95	107.3	89.4	17.9	0.30	0.07	<0.01	<0.01	0.23	<0.01	0.03	73.0	<0.01	24.4	0.03	447	366	798
C 5	04/18/95	98.3	87.9	10.4	0.47	0.11	0.09	0.09	0.27	<0.01	0.08	72.1	<0.01	22.7	0.07	465	350	730
C 5	07/21/95	103.7	93.5	10.2	0.48	0.07	<0.01	0.11	0.30	<0.01	<0.01	71.3	<0.01	23.9	0.06	450	356	674
C 5	10/05/95	106.1	82.9	23.2	0.43	<0.01	<0.01	0.08	0.36	<0.01	0.05	72.8	<0.01	25.6	0.07	426	363	382
C 6	11/09/94	102.4	95.4	7.0	0.36	0.16	0.03	<0.01	0.20	<0.01	0.06	73.3	<0.01	23.4	0.03	463	325	751
C 6	02/17/95	109.3	91.0	18.3	0.27	0.03	0.03	<0.01	0.24	<0.01	<0.01	73.3	<0.01	24.6	<0.01	472	357	674
C 7	05/13/94	226.8	84.9	141.9	0.10	0.04	0.01	<0.01	0.06	<0.01	0.01	79.9	<0.01	29.2	<0.01	521	357	835
C 7	11/09/94	99.8	93.7	6.1	0.31	0.31	0.03	<0.01	<0.01	<0.01	0.07	76.5	<0.01	29.9	0.04	466	339	718
C 7	02/17/95	108.6	87.7	20.9	0.40	0.34	<0.01	<0.01	0.06	<0.01	0.03	80.1	<0.01	31.8	0.05	486	358	809
C 7	04/18/95	91.0	86.7	4.3	0.31	0.31	0.02	<0.01	<0.01	<0.01	0.03	76.2	<0.01	30.1	0.07	460	345	753
C 7	07/21/95	72.8	65.0	7.8	0.76	0.65	<0.01	<0.01	0.11	<0.01	0.18	76.4	<0.01	31.5	0.07	476	366	832
C 7	10/05/95	107.5	84.4	23.1	0.24	0.18	<0.01	0.06	<0.01	<0.01	0.08	80.4	<0.01	33.4	0.05	484	370	390
C 8	05/13/94	217.2	81.0	136.2	3.56	0.71	0.03	<0.01	2.85	<0.01	0.06	72.6	<0.01	36.1	<0.01	514	355	835
C 8	11/09/94	103.1	89.1	14.0	8.16	5.82	<0.01	<0.01	2.34	<0.01	0.87	82.6	<0.01	37.2	<0.01	448	342	762
C 8	02/17/95	105.3	86.1	19.2	3.07	<0.01	0.04	<0.01	3.09	<0.01	0.03	73.5	<0.01	37.5	0.12	491	345	854
C 8	04/18/95	93.5	87.3	6.2	3.77	0.30	0.02	<0.01	3.47	<0.01	0.05	72.1	<0.01	37.5	0.07	519	349	799
C 8	10/05/95	95.1	80.6	14.5	4.54	1.03	<0.01	0.06	3.45	<0.01	0.18	73.8	<0.01	38.3	0.05	479	346	364
C 9	05/13/94	234.6	80.2	154.4	0.73	0.47	0.03	<0.01	0.06	<0.01	0.08	21.5	<0.01	2.9	<0.01	408	348	634
C 9	11/09/94	86.6	72.4	14.2	2.05	1.95	0.01	<0.01	0.10	<0.01	0.49	87.4	<0.01	7.4	<0.01	370	272	563
C 10	05/13/94	209.7	76.2	133.5	0.33	<0.01	0.01	<0.01	0.08	<0.01	0.03	46.5	<0.01	4.8	<0.01	426	342	499
C 10	11/09/94	93.5	74.6	18.9	0.39	0.27	<0.01	<0.01	0.12	<0.01	0.07	92.6	<0.01	7.6	<0.01	390	273	574
C 10	02/17/95	97.6	79.3	18.3	0.28	0.12	0.01	<0.01	0.16	<0.01	0.02	67.4	0.27	5.8	<0.01	415	322	686
C 10	04/18/95	80.1	65.4	14.7	0.40	0.24	0.02	<0.01	0.16	<0.01	0.05	54.8	<0.01	4.2	<0.01	330	259	534
C 10	07/21/95	103.2	94.3	8.9	0.67	0.48	0.04	<0.01	0.19	<0.01	0.11	69.4	<0.01	4.2	<0.01	433	370	753
C 10	10/05/95	93.1	80.6	12.5	0.69	0.48	<0.01	0.06	0.15	<0.01	0.21	53.1	<0.01	5.8	<0.01	410	370	390
C 11	05/13/94	194.4	72.5	121.9	0.13	<0.01	<0.01	<0.01	0.06	<0.01	0.05	57.0	<0.01	7.1	<0.01	419	325	645
C 11	11/09/94	77.5	65.1	12.4	0.28	0.28	<0.01	<0.01	<0.01	<0.01	0.05	104.0	<0.01	8.4	<0.01	373	250	585
C 11	04/18/95	79.6	67.5	12.1	0.24	0.16	0.02	<0.01	0.08	<0.01	0.04	58.4	<0.01	5.9	<0.01	362	280	565
C 11	07/21/95	82.2	81.3	0.9	0.49	0.40	0.01	<0.01	0.09	<0.01	0.13	57.8	<0.01	6.8	<0.01	383	363	629
C 12	02/17/95	102.2	86.5	15.7	2.13	0.37	0.01	<0.01	1.76	<0.01	0.27	74.2	<0.01	35.0	0.10	486	358	821
C 12	04/18/95	73.9	59.2	14.7	4.30	1.78	0.01	0.09	2.43	<0.01	0.46	98.7	0.54	10.0	<0.01	482	259	602
C 12	10/05/95	89.4	64.2	25.2	0.72	0.52	0.14	<0.01	0.20	<0.01	0.19	105.0	0.33	19.1	0.04	403	279	294
C 13	02/17/95	86.3	65.6	20.7	0.73	0.35	<0.01	<0.01	0.38	<0.01	0.25	125.0	<0.01	12.4	<0.01	406	277	686
C 14	04/18/95	89.6	84.6	5.0	2.65	1.32	0.04	0.09	1.24	<0.01	0.38	74.2	<0.01	35.6	0.07	489	340	799
C 14	10/05/95	98.2	79.7	18.5	4.32	0.53	0.09	0.29	3.50	<0.01	0.18	75.9	<0.01	38.7	0.05	452	343	361
General Use Standard'							1.50					500.0	1.40	500.0				
	Mean	116.9	80.5	36.4	1.40	0.55	0.03	0.10	1.01		0.11	71.1	0.36	21.7	0.06	443	332	674
	Median	99.6	81.0	15.3	1.03	0.30	0.02	0.09	0.50		0.06	72.1	0.31	23.4	0.05	450	343	695
	Maximum	239.8	95.6	154.4	8.16	5.82	0.14	0.29	3.50	<0.01	0.87	125.0	0.54	52.4	0.12	521	370	854
	Minimum	72.8	59.2	0.9	0.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	20.1	<0.01	2.9	<0.01	330	237	294
	Detections	59	59	59	59	49	35	9	55	0	55	59	4	59	23	59	59	59

APPENDIX D *continued*

Table D2 Results of water-chemistry analyses *(continued)*

Map ID (figure 4)	Sampling Date	*Field-Measured Parameters* Cond.	pH	Redox	Temp.	*ICP Analyses* Al	As	B	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	K	La
C 1	05/13/94	700	8.4	215	13.2	0.05	<0.01	<0.01	0.04	<0.001	99.5	<0.01	<0.01	<0.01	<0.01	0.01	3	<0.002
C 1	11/09/94	710	7.7	170	11.1	0.10	<0.01	<0.02	0.05	0.004	96.2	<0.01	<0.01	0.01	0.01	0.03	2	<0.002
C 1	04/18/95	420	7.8	200	11.6	0.06	<0.01	<0.02	0.04	<0.001	74.1	<0.01	<0.01	<0.01	<0.01	0.06	2	<0.002
C 1	07/21/95	640	8.1	117	19.5	0.04	<0.01	<0.02	0.05	<0.002	91.4	<0.01	<0.01	<0.01	<0.01	0.05	3	<0.002
C 1	10/05/95	750	8.1	125	13.6	<0.02	<0.01	0.04	0.04	<0.001	94.9	<0.01	<0.01	0.01	<0.01	0.03	4	<0.002
C 2	05/13/94	700	8.3	245	13.8	0.03	<0.01	<0.01	0.05	<0.001	96.5	<0.01	<0.01	<0.01	<0.01	0.01	3	<0.002
C 2	11/09/94	760	7.7	183	11.1	0.10	<0.01	0.04	0.04	0.002	103	<0.01	<0.01	0.01	0.01	0.03	2	<0.002
C 2	02/17/95	770	7.6	160	4.0	0.02	<0.01	<0.02	0.05	<0.002	99.2	<0.01	<0.01	<0.01	<0.01	0.01	3	<0.005
C 2	04/18/95	520	8.0	191	11.3	0.02	<0.01	<0.02	0.04	<0.001	87.5	<0.01	<0.01	<0.01	<0.01	0.01	<1	<0.002
C 2	07/21/95	690	8.3	109	19.3	0.03	<0.01	<0.02	0.04	<0.002	92.1	<0.01	<0.01	<0.01	<0.01	0.02	2	<0.002
C 2	10/05/95	770	8.2	112	14.7	<0.02	<0.01	<0.02	0.04	<0.001	95.7	<0.01	<0.01	<0.01	<0.01	0.02	3	0.008
C 3	05/13/94	800	8.1	240	13.1	0.02	<0.01	<0.01	0.05	<0.001	98.1	<0.01	<0.01	<0.01	0.01	0.01	4	<0.002
C 3	11/09/94	760	7.7	170	11.1	0.10	<0.01	<0.02	0.05	0.003	97.1	<0.01	<0.01	0.01	<0.01	0.10	5	<0.002
C 3	02/17/95	760	7.3	107	5.8	0.03	<0.01	<0.02	0.05	<0.002	101	<0.01	<0.01	<0.01	<0.01	0.06	4	<0.005
C 3	04/18/95	670	7.8	174	9.8	0.02	<0.01	<0.02	0.04	<0.001	92.9	<0.01	<0.01	<0.01	<0.01	0.01	<1	<0.002
C 3	07/21/95	710	8.1	86	18.1	0.04	<0.01	0.03	0.04	<0.002	90.6	<0.01	<0.01	<0.01	<0.01	0.03	3	<0.002
C 3	10/05/95	780	8.1	94	14.0	0.14	<0.01	<0.02	0.05	<0.001	101	<0.01	<0.01	<0.01	<0.01	0.29	3	<0.002
C 4	05/13/94	700	8.3	258	11.6	0.02	<0.01	<0.01	0.04	<0.001	89.6	<0.01	<0.01	<0.01	<0.01	0.03	<1	<0.002
C 4	11/09/94	740	7.8	171	11.1	0.10	<0.01	<0.02	0.05	<0.001	104	<0.01	<0.01	<0.01	<0.01	0.04	<1	<0.002
C 4	04/18/95	600	8.0	141	9.8	0.02	<0.01	<0.02	0.04	<0.001	83.3	<0.01	<0.01	<0.01	<0.01	0.05	<1	<0.002
C 4	07/21/95	620	8.0	68	18.3	<0.02	<0.01	<0.02	0.04	<0.002	83.7	<0.01	<0.01	<0.01	<0.01	0.07	<1	<0.002
C 4	10/05/95	710	8.1	72	15.2	<0.02	<0.01	<0.02	0.04	<0.001	87.2	<0.01	<0.01	0.01	<0.01	0.05	1	<0.002
C 5	05/13/94	700	7.5	130	8.9	0.03	<0.01	<0.01	0.03	<0.001	100	<0.01	<0.01	<0.01	<0.01	0.01	<1	<0.002
C 5	11/09/94	770	7.4	167	11.1	0.10	<0.01	<0.02	0.04	<0.001	92.4	<0.01	<0.01	<0.01	<0.01	0.05	2	<0.002
C 5	02/17/95	830	7.1	98	8.1	0.03	<0.01	<0.02	0.04	<0.002	94.0	<0.01	<0.01	<0.01	<0.01	0.03	3	<0.005
C 5	04/18/95	720	7.3	143	9.7	0.02	<0.01	<0.02	0.04	<0.001	95.9	<0.01	<0.01	<0.01	<0.01	0.06	1	<0.002
C 5	07/21/95	640	7.3	67	11.8	<0.02	<0.01	<0.02	0.03	<0.002	95.1	<0.01	<0.01	<0.01	<0.01	0.04	1	<0.002
C 5	10/05/95	790	7.5	59	13.8	<0.02	<0.01	<0.02	0.03	<0.001	90.6	<0.01	<0.01	0.01	<0.01	0.03	2	<0.002
C 6	11/09/94	740	7.1	165	11.1	0.10	<0.01	<0.02	0.04	<0.001	98.3	<0.01	<0.01	<0.01	<0.01	0.17	2	<0.002
C 6	02/17/95	860	7.1	105	8.7	0.04	<0.01	<0.02	0.04	<0.002	99.4	<0.01	<0.01	<0.01	<0.01	0.08	3	<0.005
C 7	05/13/94	800	7.6	95	10.5	0.02	<0.01	<0.01	0.05	<0.001	106	<0.01	<0.01	<0.01	<0.01	0.19	<1	<0.002
C 7	11/09/94	780	6.8	120	11.1	0.10	<0.01	<0.02	0.04	<0.001	98.7	<0.01	<0.01	<0.01	0.01	0.50	2	<0.002
C 7	02/17/95	830	7.0	-10	8.1	0.02	<0.01	<0.02	0.05	<0.002	102	<0.01	<0.01	<0.01	<0.01	0.75	2	<0.005
C 7	04/18/95	750	7.2	39	10.2	0.06	<0.01	<0.02	0.05	<0.001	97.1	<0.01	<0.01	<0.01	0.01	1.66	2	<0.002
C 7	07/21/95	700	7.4	-38	13.4	0.04	<0.01	<0.02	0.04	<0.002	101	<0.01	<0.01	<0.01	<0.01	0.53	<1	<0.002
C 7	10/05/95	810	7.6	-41	13.9	<0.02	<0.01	<0.02	0.04	<0.001	103	<0.01	<0.01	<0.01	<0.01	0.76	2	<0.002
C 8	05/13/94	800	7.8	254	16.9	0.03	<0.01	<0.01	0.04	<0.001	105	<0.01	<0.01	<0.01	<0.01	0.01	<1	<0.002
C 8	11/09/94	780	7.7	150	11.1	0.10	<0.01	<0.02	0.04	<0.001	97.3	<0.01	<0.01	<0.01	<0.01	0.02	2	<0.002
C 8	02/17/95	830	7.2	139	7.4	0.02	<0.01	<0.02	0.04	<0.002	103	<0.01	<0.01	<0.01	<0.01	0.01	2	<0.005
C 8	04/18/95	750	7.3	185	10.7	0.02	<0.01	<0.02	0.04	<0.001	116	<0.01	<0.01	<0.01	0.01	0.03	3	<0.002
C 8	10/05/95	780	7.8	94	13.9	<0.02	<0.01	0.04	0.04	<0.001	103	<0.01	<0.01	<0.01	<0.01	0.05	2	0.005
C 9	05/13/94	600	7.8	218	22.4	0.03	<0.01	0.05	0.08	<0.001	88.1	<0.01	<0.01	<0.01	<0.01	0.12	<1	<0.002
C 9	11/09/94	590	7.6	138	11.1	0.10	<0.01	<0.02	0.07	<0.001	80.9	<0.01	<0.01	0.01	0.01	0.02	1	<0.002
C 10	05/13/94	600	8.0	250	10.9	0.04	<0.01	<0.01	0.07	<0.001	87.6	<0.01	<0.01	<0.01	<0.01	0.01	<1	<0.002
C 10	11/09/94	600	7.6	150	11.1	0.10	<0.01	<0.02	0.07	0.003	84.4	<0.01	<0.01	<0.01	<0.01	0.05	2	<0.002
C 10	02/17/95	620	7.3	120	2.1	0.04	<0.01	<0.02	0.07	<0.002	86.6	<0.01	<0.01	<0.01	<0.01	0.03	<1	<0.005
C 10	04/18/95	500	7.7	225	7.9	0.05	<0.01	<0.02	0.06	<0.001	69.9	<0.01	<0.01	<0.01	<0.01	0.05	<1	<0.002
C 10	07/21/95	700	7.4	62	20.5	<0.02	<0.01	<0.02	0.09	<0.002	91.9	<0.01	<0.01	<0.01	<0.01	0.12	<1	<0.002
C 10	10/05/95	730	7.7	88	16.3	<0.02	<0.01	0.03	0.07	<0.001	86.3	<0.01	<0.01	0.01	<0.01	0.08	<1	<0.002
C 11	05/13/94	600	8.4	228	15.2	0.04	<0.01	<0.01	0.07	<0.001	87.6	<0.01	<0.01	<0.01	0.01	0.01	<1	<0.002
C 11	11/09/94	550	7.7	154	11.1	0.10	<0.01	<0.02	0.08	<0.001	81.8	<0.01	<0.01	0.01	<0.01	0.06	2	<0.002
C 11	04/18/95	550	8.2	220	9.6	0.04	<0.01	<0.02	0.07	<0.001	78.2	<0.01	<0.01	<0.01	<0.01	0.06	<1	<0.002
C 11	07/21/95	600	8.2	62	18.0	<0.02	<0.01	<0.02	0.08	<0.002	82.8	<0.01	<0.01	<0.01	<0.01	0.02	<1	<0.002
C 12	02/17/95	780	7.2	155	7.1	0.05	<0.01	<0.02	0.06	<0.002	103	<0.01	<0.01	<0.01	<0.01	0.03	<1	<0.005
C 12	04/18/95	420	7.8	198	12.0	0.12	<0.01	0.03	0.07	<0.001	141	<0.01	<0.01	<0.01	0.01	0.11	<	<0.002
C 12	10/05/95	740	7.9	88	17.0	0.09	<0.01	<0.02	0.06	<0.001	95.7	<0.01	<0.01	0.01	0.01	0.13	<1	0.008
C 13	02/17/95	720	7.0	166	6.1	0.07	<0.01	<0.02	0.05	<0.002	107	<0.01	<0.01	<0.01	<0.01	0.04	<1	<0.005
C 14	04/18/95	690	7.4	187	10.3	0.02	<0.01	<0.02	0.06	<0.001	104	<0.01	<0.01	<0.01	<0.01	0.01	2	<0.002
C 14	10/05/95	820	7.6	85	16.0	<0.02	<0.01	0.03	0.05	<0.001	96.7	<0.01	<0.01	<0.01	<0.01	0.04	3	<0.002
General Use Standard[1]			6.5–9.0				0.36	1.00	5.00			0.05		4.00	1.00	1.00		
	Mean	701	7.7	138	12.1	0.05		0.04	0.05	0.003	95.1			0.01	0.01	0.12	2	0.007
	Median	720	7.7	141	11.1	0.04		0.04	0.05	0.003	95.9			0.01	0.01	0.04	2	0.008
	Maximum	860	8.4	258	22.4	0.14	<0.01	0.05	0.09	0.004	141	<0.01	<0.01	0.01	0.01	1.66	5	0.008
	Minimum	420	6.8	-41	2.1	<0.02	<0.01	<0.01	0.03	<0.001	69.9	<0.01	<0.01	<0.01	<0.01	0.01	<1	<0.002
	Detections	59	59	59	59	47	0	8	59	4	59	0	0	10	10	59	36	3

APPENDIX D *continued*

Table D2 Results of water-chemistry analyses *(continued)*

Map ID (figure 4)	Sampling Date	*ICP Analyses (continued)* Li	Mg	Mn	Mo	Na	Ni	Pb	Sb	Sc	Se	Si	Sr	Ti	Tl	V	Zn	Zr
C 1	05/13/94	0.01	56.4	0.02	<0.01	6.5	<0.03	<0.08	<0.1	<0.003	<0.1	7.60	0.08	<0.01	<0.3	<0.01	<0.01	<0.01
C 1	11/09/94	0.01	46.3	0.02	<0.02	6.9	<0.03	<0.05	<0.2	<0.003	<0.2	5.71	0.08	<0.01	<0.4	<0.01	0.01	<0.01
C 1	04/18/95	<0.01	35.8	0.05	<0.02	24.3	<0.03	<0.05	<0.2	<0.003	<0.1	4.42	0.07	<0.01	<0.4	<0.01	<0.01	<0.02
C 1	07/21/95	<0.01	51.3	0.02	<0.02	6.5	<0.03	<0.08	<0.1	<0.003	<0.1	7.62	0.08	<0.01	<0.3	<0.01	<0.01	<0.01
C 1	10/05/95	<0.01	52.6	0.01	<0.02	7.0	<0.03	<0.08	<0.1	<0.003	<0.1	7.63	0.08	<0.01	<0.2	<0.01	<0.01	<0.01
C 2	05/13/94	<0.01	56.0	0.01	<0.01	6.8	<0.03	<0.08	<0.1	<0.003	<0.1	7.90	0.08	<0.01	<0.3	<0.01	<0.01	<0.01
C 2	11/09/94	<0.01	50.8	0.01	<0.02	5.6	<0.03	<0.05	<0.2	<0.003	<0.2	6.56	0.07	<0.01	<0.4	<0.01	<0.01	<0.01
C 2	02/17/95	<0.01	52.8	0.01	<0.02	7.0	<0.02	<0.04	<0.1	<0.005	<0.1	7.11	0.07	<0.01	0.4	<0.01	<0.01	<0.01
C 2	04/18/95	<0.01	45.7	0.01	<0.02	5.1	<0.03	<0.05	<0.2	<0.003	<0.1	6.32	0.07	<0.01	<0.4	<0.01	<0.01	<0.02
C 2	07/21/95	<0.01	50.5	0.01	<0.02	6.4	<0.03	<0.08	<0.1	<0.003	<0.1	7.47	0.08	<0.01	<0.3	<0.01	<0.01	<0.01
C 2	10/05/95	<0.01	52.3	<0.01	<0.02	6.8	<0.03	<0.08	<0.1	<0.003	<0.1	7.52	0.08	<0.01	<0.2	<0.01	<0.01	<0.01
C 3	05/13/94	<0.01	56.6	0.01	<0.01	8.0	<0.03	<0.08	<0.1	<0.003	<0.1	8.30	0.08	<0.01	<0.3	<0.01	<0.01	<0.01
C 3	11/09/94	<0.01	51.3	0.01	<0.02	7.9	<0.03	<0.05	<0.2	<0.003	<0.2	7.93	0.08	<0.01	<0.4	<0.01	<0.01	<0.01
C 3	02/17/95	<0.01	53.6	0.01	<0.02	7.6	<0.02	<0.04	<0.1	<0.005	<0.1	7.62	0.07	<0.01	<0.2	<0.01	<0.01	<0.01
C 3	04/18/95	<0.01	49.5	0.01	<0.02	7.2	<0.03	<0.05	<0.2	<0.003	<0.1	7.13	0.07	<0.01	<0.4	<0.01	<0.01	<0.02
C 3	07/21/95	<0.01	48.4	<0.01	<0.02	6.8	<0.03	<0.08	<0.1	<0.003	<0.1	7.33	0.07	<0.01	<0.3	<0.01	<0.01	<0.01
C 3	10/05/95	0.01	52.8	0.01	<0.02	7.6	<0.03	<0.08	<0.1	<0.003	<0.1	7.84	0.08	<0.01	<0.2	<0.01	<0.01	<0.01
C 4	05/13/94	<0.01	53.8	0.01	<0.01	3.4	<0.03	<0.08	<0.1	<0.003	<0.1	8.20	0.10	<0.01	<0.3	<0.01	<0.01	<0.01
C 4	11/09/94	0.01	53.0	0.01	<0.02	3.5	<0.03	<0.05	<0.2	<0.003	<0.2	7.17	0.10	<0.01	<0.4	<0.01	<0.01	<0.01
C 4	04/18/95	<0.01	45.0	0.01	<0.02	2.7	<0.03	<0.05	<0.2	<0.003	<0.1	6.60	0.09	<0.01	<0.4	<0.01	<0.01	<0.02
C 4	07/21/95	<0.01	47.0	0.02	<0.02	3.2	<0.03	<0.08	<0.1	<0.003	<0.1	7.63	0.10	<0.01	<0.3	<0.01	0.01	<0.01
C 4	10/05/95	0.01	48.8	<0.01	<0.02	3.1	<0.03	<0.08	<0.1	<0.003	<0.1	7.92	0.10	<0.01	<0.2	<0.01	<0.01	<0.01
C 5	05/13/94	<0.01	58.6	0.03	<0.01	5.2	<0.03	<0.08	<0.1	<0.003	<0.1	7.30	0.09	<0.01	<0.3	<0.01	<0.01	<0.01
C 5	11/09/94	0.01	49.4	0.03	<0.02	4.4	<0.03	<0.05	<0.2	<0.003	<0.2	6.67	0.08	<0.01	<0.4	<0.01	<0.01	<0.01
C 5	02/17/95	<0.01	51.4	0.03	<0.02	4.6	<0.02	<0.04	<0.1	<0.005	<0.1	6.62	0.08	<0.01	<0.2	<0.01	<0.01	<0.01
C 5	04/18/95	<0.01	54.7	0.04	<0.02	4.6	<0.03	<0.05	<0.2	<0.003	<0.1	6.89	0.08	<0.01	<0.4	<0.01	<0.01	<0.02
C 5	07/21/95	<0.01	51.6	0.04	<0.02	4.7	<0.03	<0.08	<0.1	<0.003	<0.1	6.79	0.08	<0.01	<0.3	<0.01	<0.01	<0.01
C 5	10/05/95	<0.01	48.4	0.03	<0.02	4.3	<0.03	<0.08	<0.1	<0.003	<0.1	6.54	0.08	<0.01	<0.2	<0.01	<0.01	<0.01
C 6	11/09/94	0.01	52.7	0.04	<0.02	4.8	<0.03	<0.05	<0.2	<0.003	<0.2	7.16	0.09	<0.01	<0.4	<0.01	0.01	<0.01
C 6	02/17/95	<0.01	54.2	0.04	<0.02	10.9	<0.02	<0.04	<0.1	<0.005	<0.1	6.96	0.09	0.01	<0.2	<0.01	<0.01	<0.01
C 7	05/13/94	0.01	62.0	0.06	<0.01	6.5	<0.03	<0.08	<0.1	<0.003	<0.1	6.70	0.09	<0.01	<0.3	<0.01	<0.01	<0.01
C 7	11/09/94	0.01	53.1	0.07	<0.02	6.2	<0.03	<0.05	<0.2	<0.003	<0.2	6.08	0.08	<0.01	<0.4	<0.01	0.01	<0.01
C 7	02/17/95	<0.01	55.7	0.07	<0.02	6.4	<0.02	<0.04	<0.1	<0.005	<0.1	6.12	0.08	0.01	<0.2	<0.01	<0.01	<0.01
C 7	04/18/95	<0.01	52.0	0.07	<0.02	19.4	<0.03	<0.05	<0.2	<0.003	<0.1	5.86	0.08	<0.01	<0.4	<0.01	<0.01	<0.02
C 7	07/21/95	<0.01	54.1	0.06	<0.02	6.2	<0.03	<0.08	<0.1	<0.003	<0.1	5.97	0.08	<0.01	<0.3	<0.01	<0.01	<0.01
C 7	10/05/95	<0.01	54.8	0.06	<0.02	6.2	<0.03	<0.08	<0.1	<0.003	<0.1	6.02	0.08	<0.01	<0.2	<0.01	<0.01	<0.01
C 8	05/13/94	<0.01	61.2	0.01	<0.01	8.1	<0.03	<0.08	<0.1	<0.003	<0.1	7.60	0.09	<0.01	<0.3	<0.01	<0.01	<0.01
C 8	11/09/94	0.01	49.6	0.01	<0.02	7.1	<0.03	<0.05	<0.2	<0.003	<0.2	6.23	0.08	<0.01	<0.4	<0.01	<0.01	<0.01
C 8	02/17/95	<0.01	56.8	0.01	<0.02	10.6	<0.02	<0.04	<0.1	<0.005	<0.1	7.21	0.08	0.01	<0.2	<0.01	<0.01	<0.01
C 8	04/18/95	0.01	55.6	0.02	<0.02	7.8	<0.03	<0.05	<0.2	<0.003	<0.1	6.99	0.09	<0.01	<0.4	<0.01	<0.01	<0.02
C 8	10/05/95	0.01	53.9	0.01	<0.02	7.7	<0.03	<0.08	<0.1	<0.003	<0.1	7.21	0.08	<0.01	<0.2	<0.01	<0.01	<0.01
C 9	05/13/94	<0.01	45.5	0.07	<0.01	3.9	<0.03	<0.08	<0.1	<0.003	<0.1	7.70	0.11	<0.01	<0.3	<0.01	<0.01	<0.01
C 9	11/09/94	<0.01	40.7	0.01	<0.02	4.2	<0.03	<0.05	<0.2	<0.003	<0.2	5.82	0.10	<0.01	<0.4	<0.01	0.01	<0.01
C 10	05/13/94	<0.01	50.3	0.03	<0.01	4.3	<0.03	<0.08	<0.1	<0.003	<0.1	8.80	0.11	<0.01	<0.3	<0.01	<0.01	<0.01
C 10	11/09/94	0.01	43.5	0.02	<0.02	4.3	<0.03	<0.05	<0.2	<0.003	<0.2	6.81	0.10	<0.01	<0.4	<0.01	<0.01	<0.01
C 10	02/17/95	<0.01	48.3	0.02	<0.02	4.3	<0.02	<0.04	<0.1	<0.005	<0.1	6.54	0.11	<0.01	<0.2	<0.01	<0.01	<0.01
C 10	04/18/95	<0.01	37.7	0.01	<0.02	3.3	<0.03	<0.05	<0.2	<0.003	<0.1	6.18	0.08	<0.01	<0.4	<0.01	<0.01	<0.02
C 10	07/21/95	<0.01	49.4	0.05	<0.02	3.7	<0.03	<0.08	<0.1	<0.003	<0.1	8.13	0.14	<0.01	<0.3	<0.01	<0.01	<0.01
C 10	10/05/95	0.01	47.3	0.04	<0.02	3.8	<0.03	<0.08	<0.1	<0.003	<0.1	6.31	0.13	<0.01	<0.2	<0.01	<0.01	<0.01
C 11	05/13/94	<0.01	48.6	0.06	<0.01	3.8	<0.03	<0.08	<0.1	<0.003	<0.1	8.50	0.09	<0.01	<0.3	<0.01	<0.01	<0.01
C 11	11/09/94	<0.01	40.8	0.03	<0.02	4.0	<0.03	<0.05	<0.2	<0.003	<0.2	6.81	0.08	<0.01	<0.4	<0.01	<0.01	<0.01
C 11	04/18/95	<0.01	40.3	0.09	<0.02	5.6	<0.03	<0.05	<0.2	<0.003	<0.1	6.53	0.08	<0.01	<0.4	<0.01	<0.01	<0.02
C 11	07/21/95	<0.01	42.8	0.04	<0.02	3.6	<0.03	<0.08	<0.1	<0.003	<0.1	7.87	0.09	<0.01	<0.3	<0.01	<0.01	<0.01
C 12	02/17/95	<0.01	55.4	0.07	<0.02	7.4	<0.02	<0.04	<0.1	<0.005	<0.1	6.39	0.09	0.01	<0.2	<0.01	<0.01	<0.01
C 12	04/18/95	<0.01	31.4	0.04	<0.02	4.0	<0.03	<0.05	<0.2	<0.003	<0.1	3.21	0.09	<0.01	<0.4	<0.01	0.01	<0.02
C 12	10/05/95	<0.01	39.6	0.03	<0.02	3.9	<0.03	<0.08	<0.1	<0.003	<0.1	6.16	0.12	<0.01	<0.2	<0.01	0.01	<0.01
C 13	02/17/95	<0.01	33.7	0.03	<0.02	2.3	<0.02	<0.04	<0.1	<0.005	<0.1	4.05	0.09	0.01	<0.2	<0.01	0.01	<0.01
C 14	04/18/95	0.01	55.5	0.11	<0.02	8.0	<0.03	<0.05	<0.2	<0.003	<0.1	6.13	0.08	<0.01	<0.4	<0.01	<0.01	<0.02
C 14	10/05/95	0.01	51.0	0.06	<0.02	7.2	<0.03	<0.08	<0.1	<0.003	<0.1	6.37	0.08	<0.01	<0.2	<0.01	<0.01	<0.01
General Use Standard[1]				1.00			1.00	0.10			1.0						1.00	
	Mean	0.01	49.9	0.03		6.2						6.89	0.09	0.01	0.4		0.01	
	Median	0.01	51.3	0.03		6.2						6.96	0.08	0.01	0.4		0.01	
	Maximum	0.01	62.0	0.11	<0.02	24.3	<0.03	<0.08	<0.2	<0.005	<0.2	8.80	0.14	0.01	0.4	<0.01	0.01	<0.02
	Minimum	<0.01	31.4	<0.01	<0.01	2.3	<0.02	<0.04	<0.1	<0.003	<0.1	3.21	0.07	<0.01	<0.2	<0.01	<0.01	<0.01
	Detections	16	59	56	0	59	0	0	0	0	0	59	59	5	1	0	8	